MACHINERY.

October, 1904.

THE DE LAVAL STEAM TURBINE COMPANY.

THEIR WORKS AND PRODUCT, WITH SKETCH OF DE LAVAL, THE INVENTOR.

Carl Gustaf P. De Laval, the Swedish Inventor.

The works of the De Laval Steam Turbine Co., Trenton, N. J., were built in 1901 and occupy a unique position among the machine shops of the country in that they were the first shops in America to be devoted exclusively to the manufacture of steam turbines. The buildings embody the most modern ideas, and in design follow out certain desirable features of construction of the parent shops at Stockholm, Sweden, where the original De Laval Company is located. Besides the American and Swedish companies there are also the French De Laval Company (Societe de Laval), located at Paris, and the English company (Greenwood & Batley), at Leeds, England, so that the American works are one of a system of factories engaged in the manufacture of steam turbines and turbine machinery, under the De Laval patents, in different parts of the world.

Since the works were first put into operation at Trenton, the methods of manufacture have been systematized until the point has been reached where the quality of product, both in the matter of finish and accuracy of the individual piece and in the interchangeability of parts, is to be classed with the best work of our leading machine tool shops. This fact alone places the De Laval Company in a unique position among concerns manufacturing steam machinery, for up to the advent of the steam turbine it has not been thought necessary, or even possible, to manufacture parts of steam engines or other prime movers of corresponding sizes on the strictly interchangeable plan. In a subsequent article something will be told about the interesting methods of manufacture carried on at this plant, and the special machinery in use.

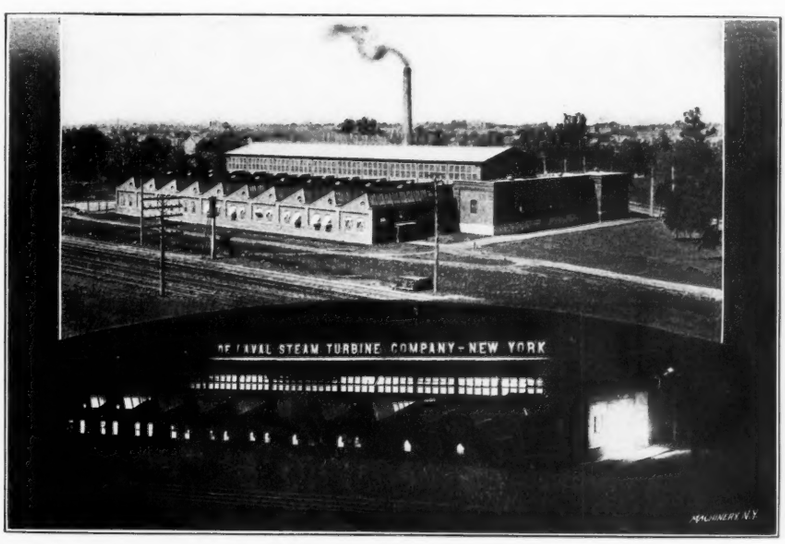

Fig 1. The Plant of the De Laval Steam Turbine Company, Trenton, N J., by day and by night. The main building is nearly a square structure, 200 by 210 feet, with a high crane shop running through the centerand sections on either side lighted by saw-tooth roof. At night the roof sign is lighted by reflected incandescent light generated by a turbine unit. This turbine is started after the plant is shut down at night and runs for four hours on the steem pressure remaining in the boilers, without additional firing. Steam is thus utilized which would ordinarily be lost at night by radiation.

The De Laval steam turbine must run at such extremely high speeds and, in order to compete with the steam engine, must be so reliable for constant service day in and day out, that it is absolutely necessary to have materials and workmanship as nearly faultless as possible. In fact, it is probably because of the possibility of securing uniformly high-grade materials and superior machine work that the turbine has proven its reliability under constant and severe service; for without these it would not be feasible to run a turbine wheel at 30,000 revolutions or more a minute, nor gears at a peripheral speed of eight or ten thousand feet a minute. The foreign De Laval companies have in operation about 3,000 on land and about 500 on shipboard, making more of this type than of all other foreign turbines combined; although it has not been considered advisable to construct the De Laval turbine in sizes larger than 200 K. W. capacity, so that the total horse power of these machines would be smaller in proportion than of the others. The first turbine built by the American company was in the fall of 1901, since which time over 400 have been completed, aggregating about 39,000 horse power.

Dr. Gustaf De Laval.

The original De Laval steam turbine is the invention of Dr. Gustaf De Laval, the famous Swedish scientist whose portrait appears on this page. Dr. De Laval was born at Blasenborg, Sweden, in 1845. He was educated at the University of Upsala, Sweden, and the technical University of Stockholm, where he graduated with highest honors in 1866. He was then employed with the Stora Kopparberg Mining Co., but believing his training not sufficient he decided to take a special course of several years' duration in physics and mathematics, at the University of Upsala, where he received the degree of Doctor of Philosophy. He again entered the service of the mining company and became interested in the erection of a plant for the manufacture of sulphur. Later he entered the service of the Kloster Iron Works, Germany, as mechanical engineer, and shortly afterward made his first two inventions—one relative to a new strainer, which was to effect a more perfect separation of air in Bessemer converters, and the other a crucible for galvanizing purposes. He experimented on centrifugal machinery and this led to his first ideas in connection with the centrifugal cream separators, which he believed would become of enormous importance to the agricultural and dairy industry if developed and perfected. His judgment in this has proven to be correct. The results of his efforts, in the dairy industry throughout the world, easily place him among the great inventors who have reduced the labors of mankind by their work. As the Kloster Iron Co. did not appreciate the importance of this invention he resigned and returned to Stockholm with the determination to thoroughly develop his cream separator ideas. These ideas were so radical that they met with considerable opposition, but he finally produced a commercially successful machine, and although it has since been modified the general principles have remained the same. Over 600,000 De Laval cream sep-

arators are in service to-day throughout the world; the American Separator Company making the cream separators has an extensive plant at Poughkeepsie, N. Y.

Dr. De Laval also perfected other useful inventions in connection with dairy apparatus, one of which was the "lacto-

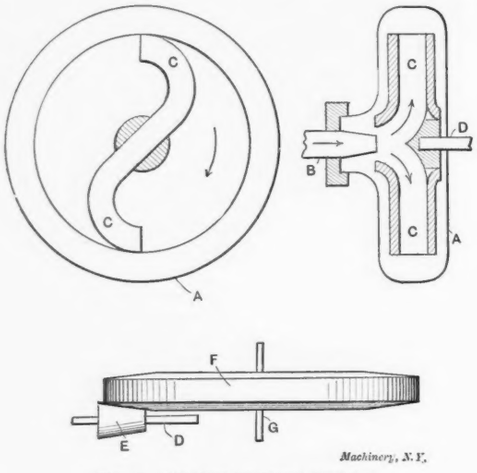

Fig. 2. The first De Laval Turbine.

meter," by which the percentage of butter fat in milk could be determined in a simple manner, and the use of which modified the method of paying for milk, by dairy companies. Formerly milk had been paid for either by the quantity of milk itself or by the quantity of cream, without regard to the quantity of butter which the milk was capable of producing. The field of activity of the inventor, however, was not confined solely to agricultural machinery, for Dr. De Laval established a factory for stamping out utensils in steel, which resulted in a large and profitable industry, and he also devoted considerable time to experiments with a new type of steamboat.

In the manufacture of his separator he conceived the idea of a steam turbine as an ideal motor for driving the separator, which must itself run at extremely high speeds, and from this has grown the De Laval steam turbine industry.

About 1882 Dr. De Laval invented his first steam turbine, which was on the principle of the Hero engine. This is illustrated diagrammatically in Fig. 2. Steam (or other fluid) entered the casing *A* by nozzle *B* and passed the curved hollow arms *C C*, formed like the buckets of an outward-flow hydraulic turbine, and the passage of steam along them caused them to rotate shaft *D*. This shaft drove another at a slower speed by friction wheels, the requisite pressure between friction surfaces being obtained by the axial thrust of the turbine wheel. The first commercially practical De Laval turbine was built in 1883 and used for driving a cream separator, to which it was direct-connected. It was of the reaction type, along the lines described above, but its efficiency was low on account of the imperfect expansion of the steam. Five years later, in 1888, he invented and used the diverging expansion nozzle in which the steam was completely expanded, and which mainly is responsible for the efficiency of the De Laval turbine. He had experimented with a steam nozzle for sand blast purposes as far back as 1870 but did not hit upon the idea of the diverging nozzle until the later date. The complete expansion of the steam in the diverging nozzle necessitated considerably higher wheel velocities than he had used before, and in order to overcome the great difficulty in balancing a wheel accurately enough to revolve around its center of gravity at a peripheral velocity sometimes as high as 1,850 feet per second, without causing destructive side pressure upon the bearings, he adopted the flexible shaft which, with the diverging nozzle, is employed in the De Laval turbine of to-day. These characteristic features, as shown in Fig. 3, have become so identified with the De Laval turbine that a representation of them is used as a trade mark by the company.

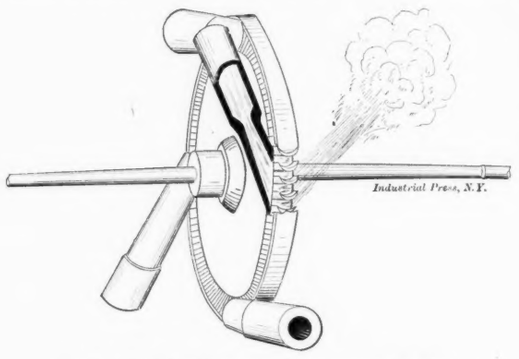

Fig. 3. The Main Elements of the present Turbine.

Fig. 4. Cross-section of Shop on Line X X, Fig. 8.

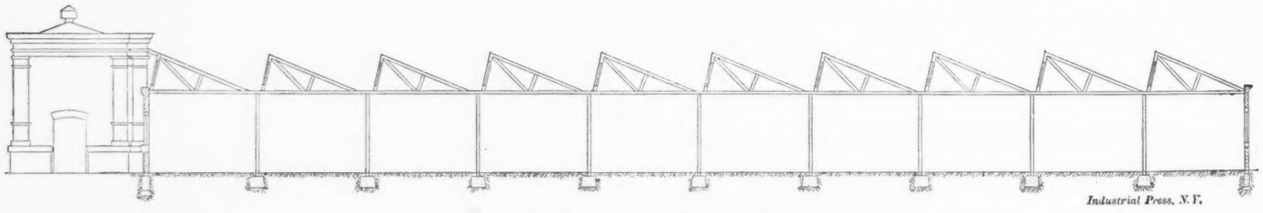

Fig. 5. Cross-section on Line Y Y, Fig. 8.

Dr. De Laval has had many distinguished honors bestowed on him by scientific and other societies and he has also served his government in various public capacities.

The De Laval Shops.

The shops at Trenton are located just outside the city limits, directly on the New York division of the Pennsylvania

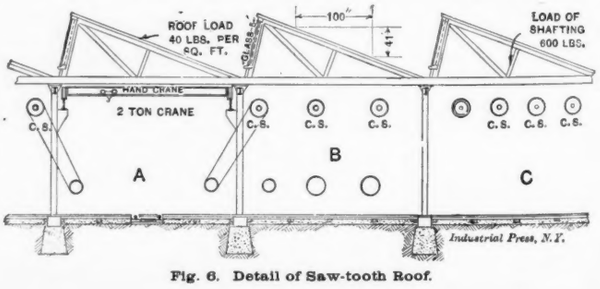

Fig. 6. Detail of Saw-tooth Roof.

Fig. 7. Side Elevation of the De Laval Works. Engine and Boiler House at the Right.

Railroad. The plot of ground contains about 10 acres and is large enough to allow an extension of about 900 feet in the length of the building, which is now 200 feet long. As stated, the buildings are of the saw-tooth type with a center crane shop 51 feet wide. The plan of the works is shown in Fig. 8 and cross-sections of the shops in Figs. 4, 5 and 6. Fig. 4 is a section taken on the line *X X*, in which the crane shop appears at the center; and the saw-tooth roof sections are shown in longitudinal section at either side. Fig. 5 is a section on the line *Y Y*, and in Fig. 6 is a detail of the saw-tooth roof construction, in which is indicated the location of one of the traveling hand cranes by which work is brought to the machine tools. The positions of the shafting are also indicated. The shop is served by two sidings from the railroad and also by its own individual shop tracks for transferring castings and completed machines from one part of the works to another. At present the offices and drawing rooms are located at *A*, Fig. 8, in one corner of the shop building, but an office building at the front of the shop is contemplated, as indicated in the plan.

The side view of the works, Fig. 7, shows the relative proportions of the main shop and the lower sections, as well as the location of the engine house, testing laboratory, etc.

Power is supplied by a steam turbine unit of 200 K. W. capacity built in Sweden, which has been in constant service almost without interruption since its installation, and the spiral gears and pinion and other parts, such as bearings, show no perceptible wear. The works are electrically driven, the smaller tools by the group system and the larger ones by individual motors. An interesting feature is the testing room, shown at *F* in Fig. 12. Here all turbine units are tested before shipping. The testing room is equipped with a large water rheostat, the water tanks being placed outside the building, after the usual custom, and there are also two

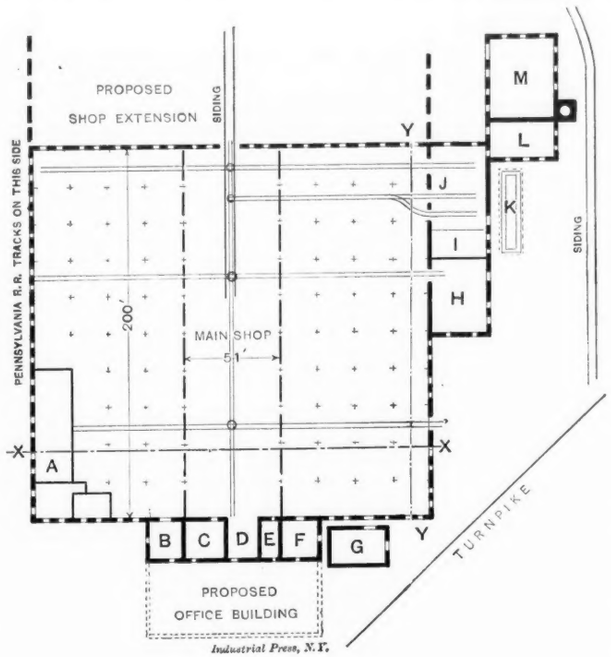

FIG. 8. PLAN OF WORKS.

A.—Offices and Drawing Room.
B.—Wash Room.
C—Lavatory
D—General Entrance.
E.—Timekeeper's Room.
F—Wash Room.
G.—Pattern Safe
H.—Blacksmith Shop.
I.—Testing Office.
J.—Testing Room.
K.—Water Tank
L.—Engine Room
M.—Boiler Room

tanks beneath the floor of the testing room, to enable the centrifugal pumps, which form an important part of the products of the company, to be readily tested. The illustration *F*, Fig. 12, was taken while Prof. Denton, of Stevens Institute of Technology and Mr. Wm. Kent, consulting engineer, were conducting a trial of centrifugal pumps referred to later.

In the first illustration, showing the plant by day and by night, the illuminated sign is a conspicuous feature of the view, at night. This sign is painted a light cream color and is visible at night by reflected light by means of incandescent lamps. The lamps are placed in a reflector at the top of the letters, and three or four feet in front of same. It is interesting to note that the sign is lighted at practically no cost; that is, the boiler plant which has a capacity of 500 H. P. with a steam pressure of 200 pounds per square inch was found to be sufficiently large to operate a 30 H. P., 20 K. W. turbine dynamo running at about 70 pounds of steam pressure for four hours each night, practically without firing. One of these units was therefore installed, and the steam used for operating it after the close of the shops is merely that which was formerly wasted by morning through radiation, etc. All that is necessary is to place about 15 or 20 shovelfuls of coal on the grate at 10 o'clock at night. The lights are turned on at 7 o'clock and shut off at 11, after which the fires are banked the same as was formerly done after shutting down the shop. The machine is looked after by the regular watchman and therefore does not cost anything for attendance.

Electric Generating Sets.

The essential features of the DeLaval turbine are familiar to many of our readers; and, in any case, as it is proposed to enter into a detailed description of the construction in a subsequent article it will not be necessary to give more than passing notice to its features in the present article.

First to be noted in the turbine are the bucket wheel, flexible shaft, and the ring of nozzles, as mentioned above. The wheel rotates in a steel casing and the shaft is supported in bearings outside of the casing and also by a type of spherical stuffing box in the walls, to prevent the passage of steam or air around the shaft.

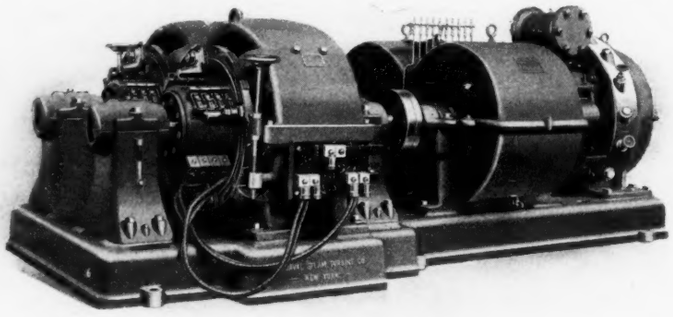

Fig. 9. Electric Generating Set, with Double Direct-current Bullock Generators.

On one end of the flexible shaft is a small spiral pinion which, in the smaller sizes, meshes with a single large spiral gear, and the larger sizes with two gears placed one on each side of the pinion. This latter arrangement balances the thrust of the gear transmission and also has other advantages for electrical generating and for driving compound pumps, as will shortly be explained. The turbine wheel rotates at speeds ranging from 10,000 to 30,000 revolutions per minute, and the smaller sizes have run up to 50,000 revolutions per minute, or more, under test. The gear shafts are reduced in speed so as to rotate at from 900 to 3,000 revolutions per minute, according to the size of the machine, which has been found satisfactory for dynamo driving and unusually well adapted for centrifugal pumps and blowers.

De Laval turbines find their widest application in connection with electrical generators. The turbines and generators are mounted as one unit on a single bedplate, and are all tested under full load before leaving the factory. At present the electric generating units are built in sizes of from 7 to 300 brake horse power, or 4-6/10 to 200 kilowatts. Up to 55 horse power, the De Laval turbine is built with the single large gear driven by the pinion on the turbine shaft; and in sizes above 55 horse power where the two-gear transmission is used, with two generators mounted side by side, as in the illustration Fig. 9. These larger sizes are especially

Fig. 11. Drawing Room.

adapted for factory purposes as they can be used either on a two- or three-wire system, running two voltages from the same unit, so that the motors distributed throughout the factory can be operated at one voltage and the lights at another. Thus, if 125-volt generators are supplied the lighting circuit would be connected in parallel, giving 125 volts for this purpose, and the motor circuit in series giving 250 volts. Owing to the short distance between the shaft centers it is possible to combine what would otherwise be two separate generator frames into one, at the same time leaving two openings in which the armatures revolve. The novelty of the arrangement is confined solely to its mechanical construction, and the dual generator is really nothing more than two generators separate in all their functions, but with their frames combined in a single casting.

When it comes to applying the turbine to alternating current generators provision must be made for rotors of larger diameter than the armature of the direct-current machines. Accordingly the generators, instead of being side by side are placed one in advance of the other. The size of the generator castings, therefore, is limited only by the condition that the frame of the machine nearest the turbine shall not come in contact with the driving shaft which passes by it to the generator furthest from the turbine. With this arrangement there is ample room for the alternating current machines when operated at the speeds of the geared shafts. The alternating current set makes a neat and compact unit, and the generators run at a high enough speed so that the exciter

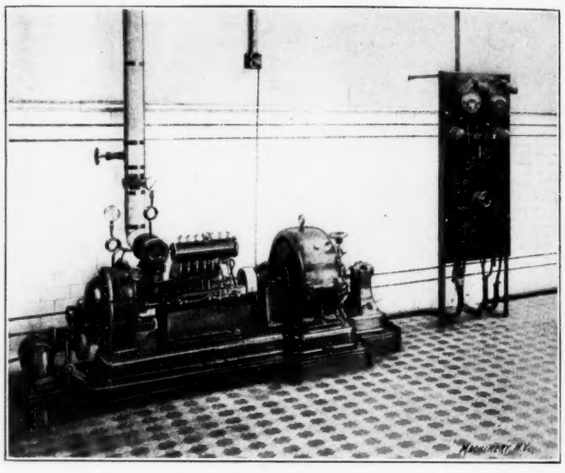

Fig. 10. Thirty H. P. Generating Set in Power Plant for Lighting the Sign on Roof of Building (Fig. 1)

can be connected directly with the end of one of the gear shafts, thus dispensing with a belt connection.

Application to Centrifugal Pumps.

One of the successful uses of the De Laval turbine is in the operation of centrifugal pumps. This has not been considered as efficient as the plunger pump, mainly because of the low speed and imperfect design of such apparatus, and it has also been adapted only to low lifts. As the De Laval Steam Turbine Company were building high-speed turbines, however, which ran at speeds almost exactly the same as would be required to produce maximum efficiency in centrifugal pumps adapted to the different sizes of turbines, it was decided to design a series of pumps, of improved mechanical construction, which would admit of the high speeds necessary, and which would also enable the pumps to work against high heads. These pumps are supplied in connection with the turbines, or independently, to be driven by electric motor, when it is desired to locate the pump apart from the prime mover. The smaller units consist of a single pump, just as the small generator units have a single generator; but the larger units have two pumps driven by the double-gear turbine, one pump being connected to each gear shaft, permitting their operation in parallel for low pressure, and in series when high lifts are desired. Standard sets are built in sizes from 7 to 300 horse power for all heads up to 300 feet, handling from 90 to 26,000 gallons per minute. Lately a high-pressure centrifugal has been developed with the forcing pump having a runner of very small diameter

attached to the turbine shaft and rotating at the extremely high speed of that shaft. The centrifugal force developed by the runner under these conditions makes it possible to pump against heads of 600 to 1,000 feet, and to use the pump for boiler feeding. A runner operating at such high speed, runner and shaft, is shown in Fig. 15, is divided horizontally through the center of the main bearing so that when the cover is removed a thorough examination may be made of all the working parts or any of the pipe connections. Usually in centrifugal pumps the packing about the shaft serves in part

FIG. 12. INTERIOR VIEWS OF THE DE LAVAL WORKS.

A View of Crane Shop
B. Erecting Department for Small Turbines and Pumps, etc.
C Lathe Department, showing the Excellent Lighting from the Sawtooth Roof.
D. The Large and Model Stock Room.
E. Engine Room, with 200 K.W. Swedish Turbine.
F. Testing Room Test of Centrifugal Pump under way by Messrs. Denton & Kent.

however, would force out the water more rapidly than it could draw it in by suction, or under atmospheric pressure only, and hence the pressure pump is flooded with water at sufficient pressure to ensure an adequate supply, by a pump on the geared shaft.

The pump case, the lower half of which, together with the as a bearing and soon becomes worn; but in this machine the bearings are entirely independent of the shaft packing, and are of the ring-oiling type. The lubricant thus cannot enter the pump chamber, which is important where a liquid would be damaged by the oil. Where hot water is to be handled flax packing is used, and where cold water is pumped

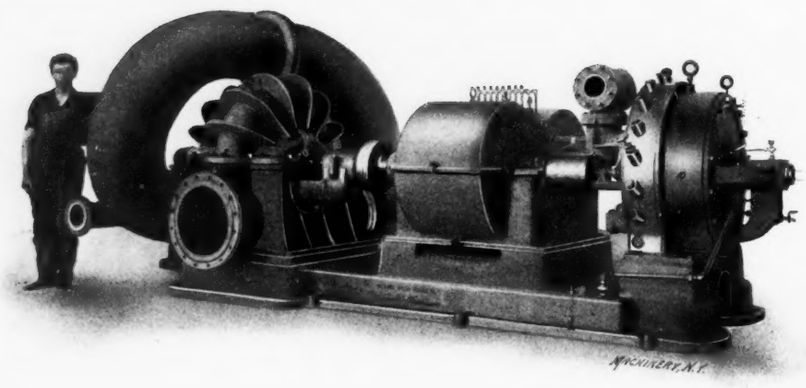

Fig. 13. Turbine Driving Two-stage Centrifugal Pump.

a cupped leather packing is employed, which is set out by the water pressure and prevents leakage of both water and air.

Water is drawn into the lower part of the pump casing and enters the runner at its center and is thrown outward through the runner in a radial direction by centrifugal force. The suction pipe connects with the portions of the casing

Fig. 14. Runner of Centrifugal Pump.

located at each side of the runner, Fig. 15, and the discharge pipe connects with the central portion in which the runner itself is located. The suction and discharge chambers are separated by vertical webs in the pump casing, bored to fit the cylindrical ends of the runner, as clearly indicated in Fig. 15. The liquid must therefore flow into and through the runner in order to pass from the suction into the discharge chambers. A channel cored in the casing runs from the high-pressure chamber to the packing glands and sets out the packings, as mentioned above. The outside of the packing is subjected only to the pressure of the suction chambers. The shaft is made of steel and provided with brass protecting sleeves at the packings and which also extend inward so as to prevent the steel shaft coming in contact with the liquid to be pumped. The runners are usually of bronze so that pumps may be used for corrosive liquids.

The development of centrifugal pumps at these works, and in connection with the De Laval turbine, it may be said, is only one instance where the centrifugal pump appears to be gaining ground over its older rival. Centrifugal pumps are used for general pumping conditions such as water works, irrigation, condenser circulation, boiler feeding, pumping pulp, sewage, heavy oils, etc. As constructed by the De Laval Company they give excellent satisfaction in handling liquids containing grit, because the only part to wear are the runners,

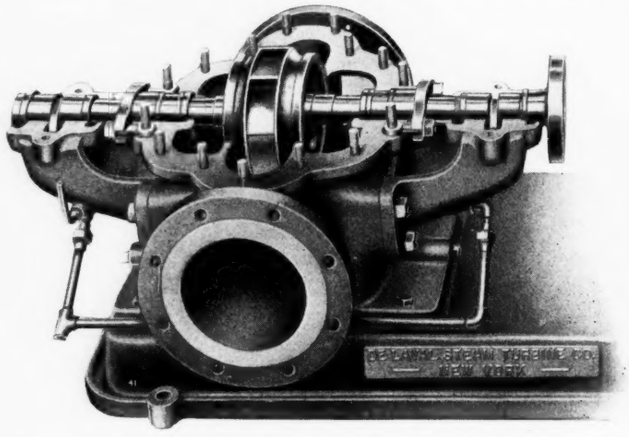

Fig. 15. Centrifugal Pump with top of Casing Removed.

the brass sleeves and the bearings; and as all the parts are interchangeable and easily accessible, any of them can be replaced on short notice. Such pumps have the advantage of absence of valves and water hammers, freedom from accidents due to breaks in pipe lines or losses in pressure, and the possibility of limiting the maximum obtainable pressure to any desired amount, by simply regulating the speed of

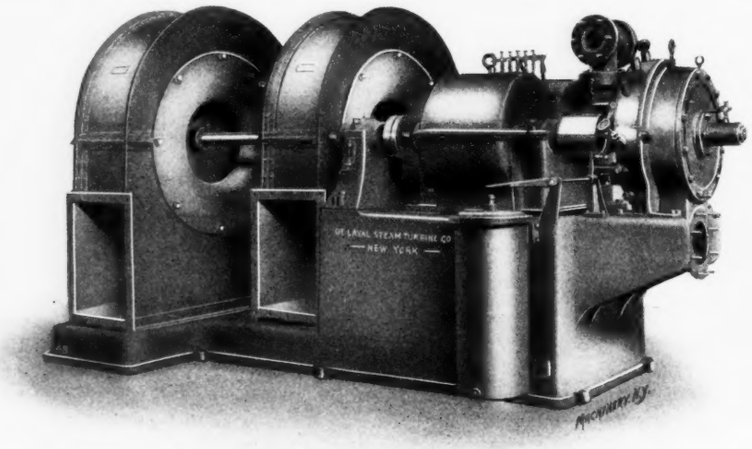

Fig. 16. Sirocco Blower set with 300 H. P. Turbine.

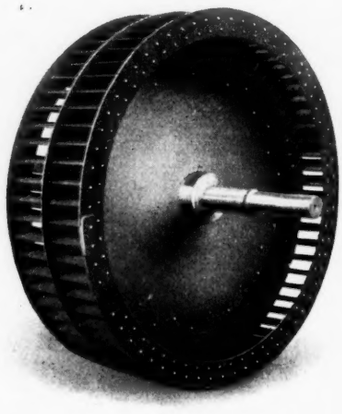

Fig. 17. Runner of Sirocco Blower.

rotation, thus insuring safety of parts of pump and pipe line.

Three centrifugal pumps were recently tested by Prof. Denton and Mr. Wm. Kent at the De Laval testing laboratory, and the results were summarized in the August number of MACHINERY. No. 1 was a single-stage machine designed to lift 1,700 gallons of water per minute against a head of 100 feet. It was driven by a 55 horse power turbine with a speed reduction of 10 to 1, and was found to require a maximum of 44½ horse power. The efficiency of the pump to the brake horse power of the turbine ranges from .743 to .756; the duty about 61,000,000 foot pounds per 1,000 pounds of steam, and the steam consumption per brake horse power about 24.25 pounds per brake horse power hour. No. 2 pump was driven by electric motor and showed similar results to the above. The third pump was a two-stage machine designed to lift 250 gallons per minute against a head of 700 feet with a large runner turning at the rate of 2,050 revolutions per minute and the small one at the rate of 20,500 revolutions per minute. This was one of the new high-pressure pumps with a small runner connected directly to the turbine shaft. The duty in million foot pounds ranges from 41.55 at a head of 494 feet to 48.88 at a head of 781 feet.

Blower Sets.

Another field where the De Laval turbine is well adapted is for direct connection to blowers for water pressures between 4 and 21 inches. The high velocity of the turbine makes it feasible to use such blower units for locations and pressures where the positive acting impeller blowers have been employed. The turbine is used in connection with blowers of the Sturtevant and Sirocco type. When directly connected to the blowers, the whole forms a compact unit, and eliminates the trouble from tight belts and heated bearings met with in attempting to use blowers for high pressures. A Sirocco blower set is illustrated in Fig. 16, and in Fig. 17 is a runner for one of these blowers. The blades of the runner are narrow and ranged around the circumference. They are concave and the runner rotates so that the concave sides lead. The theory of the blower is the reverse of the theory of a turbine water wheel; that is, the escaping air is the reverse in direction and corresponds in velocity to the jet of water which impinges against the blades of a turbine and like the jet of water has a higher velocity than either of the other components forming the parallelogram of forces acting at the edge of the blades. The air therefore has an augmented velocity with this type of runner at the point of escape which makes this type compact for a given capacity. The Sirocco blower is well adapted for the double-shaft turbine because it is of smaller diameter for a given capacity than the ordinary type; and by arranging the two blowers as in Fig 16 so they overlap in a manner similar to the arrangement of the alternating current generating set mentioned above, there is room for blowers of the required diameter for the speed at which the geared turbine shafts run. At the front of the bedplate, Fig. 16, there will be noticed a vertical cylinder, which is a regulator connected with the governor for varying the speed of the turbine slightly in order to maintain a constant air pressure. This cylinder is connected with the discharge ducts of the blowers and contains a weighted plunger which balances the air pressure underneath.

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The serial articles "A Review of Steam Turbine Patents," and "Variable-speed Motors," the latter by Mr. Baxter, are omitted from this number of the paper, but will appear in the November issue.

* * *

What should prove an important discovery, if practicable, is that of a Philadelphia inventor for alloying copper with iron. Mr. Darling believes that he has discovered a process whereby a perfectly homogeneous alloy of copper and iron can be made in varying proportions up to 85 per cent. iron. An oxide of iron, either hematite or black oxide, is used, and if, for instance, a fifty per cent. alloy is wanted, three parts of oxide are mixed with one part of calcium carbide for the iron constituent; eighteen parts of this iron constituent are used with eight parts of copper. The copper is first melted in a crucible and the iron oxide mixture is slowly added a little at a time as the temperature is gradually increased.

TOOL STEEL FORGING AND TEMPERING.*

Air hardening or special steel is a combination of various metals in various proportions with iron and carbon. These alloys give steel the power of holding an edge at a temperature, say, of 600 F. when the cutting edge of carbon steel is ruined. Various modes of treatment are specified or given as directions by the manufacturers, but by experiment the toolsmith occasionally treats the steel in a different manner, and gets better results. As to treatment most of these steels require the point to be slightly fused before cooling and grinding. This we would imagine turns the cement carbon to hardening carbon, and brings the outer surface up to the hardness of chilled cast iron, when under the influence of the air blast. Tools made from this steel should have short points and the steel should be of the largest section that can be used with the least possible clearance so as to conduct the heat away as rapidly as possible.

Air hardening is generally used for rough work where surplus metal has to be removed at a rapid rate and should be ground on wet grinders. Several brands of this special steel are almost unworkable or rather unforgeable. This class is not brought up to a weld at the point for the purpose of hardening, but is cooled in air blast; other brands again can be forged at the same heat as ordinary tool steel. These last are more economical to use, for when they are too short they can be drawn out for smaller work. The high prices being taken into consideration the unworkable grades are almost valueless when too short. By unworkable is meant those kinds that are used without forging, being cut off and shaped on an emery grinder. We must also bear in mind that since air-hardening steel deteriorates in heating and working at the forge, this process cannot be carried on as often as with carbon steel.

Carbon or tool steel holds a finer edge than the air-hardening variety and can be forged or worked into any shape required, and will always be used for tools required for exact work and tools urged by impact. There should be about three grades, the first for taps, milling cutters, reamers and screw-cutting dies, also for special tools used in tool making lathes; the next grade for machinists' chisels, cold sets, hammers, button sets, hot chisels, punches for machines, shear blades, etc.; the next grade for flatters, swedges, dies for working hot metals, bolt heading and forging machines. These latter can be made from open hearth steel.

Where there is a furnace for heating tools and a pyrometer to gage the heat, the tool question is reduced to a science. What is wanted is a good grade of steel for the tool required, then there is no danger of a poor tool. In making tools we must take into consideration the cost of such tools; first the cost of the steel in the bar; second, the making of the tools. A third consideration is the endurance of the tool, and taken in connection with the rate at which the tool can work determines very largely its economy. In most cases the wear and the cost of redressing and regrinding is less for tools made of high grade than of low grade steel, so that it is generally cheaper to make all tools of a good grade of steel than an inferior grade. We would remind you that at all times in forging and tempering tools it is necessary to have a good clean fire with plenty of suitable fuel between the tuyere iron and the tool to prevent the cold blast coming in contact with the tool, and to avoid too high a heat as there are more tools spoiled by overheating than otherwise.

In annealing it is impossible to avoid a slight lowering of the percentage of carbon on the surface of the annealed metal; the decarbonization takes place to a depth of 1-16 to ⅛ inch. In every case where the finished article, such as dies or cutters, is to be hardened this partially decarbonized skin should be removed before the steel is machined to finished size or shape, so sufficient stock must be allowed for this purpose when forged.

There is one great evil that is hard to overcome, *i. e.*, the many brands of steel that will accumulate in the average steel room. The tool smith may expect to find from six to ten different brands of steel, with the labels defaced, con-

* Abstract of report submitted by Mr. R. H. Henderson to the Twelfth Annual Convention of the National Railroad Blacksmiths' Association at Indianapolis, August 18, 1904.

sequently he is at a loss to know what he is using. When in doubt we know of no better way than to follow the recommendation of the committee on the treatment of high carbon steel of the eighth annual report as follows: Select the nearest size steel required for the tool you wish to make, draw the same down to a point. If this can be done without fracture you may assume the quality is good. The lowest heat that will give the desired hardness is the best, and if on breaking the point you find that the steel has a finer grain than the original bar the question of quality and temper is cheaply settled. This simple test will repay the cost many times over. If the steel manufacturers would brand their steel on the ends of the bars with their brands, also the number on each bar to denote its carbon temper—5, 6, 7 denoting 50, 60, 70 per cent. of carbon, respectively, the practice would greatly reduce the number of poor tools. When this practice is followed the tool-smith should stamp each tool where practicable with the corresponding number on the bar so that in redressing and tempering those tools they will know just what grade of steel they were handling and can govern themselves accordingly.

* * *

FROM MR. BLAKE.

Editor MACHINERY:

In reference to the articles in the last number by Messrs. Graham and Myers, in criticism of C. F. Blake's article in a previous issue upon "Beams and Planes Eccentrically Loaded and Severally Supported," we have the following communication from Mr. Blake:

"I should explain that my article was not sent as a finished, scientific treatise of the subject, but only as *one* attempt to solve a difficult problem, about which nothing could be found in a well-equipped engineering library; and I thought it time to make this explanation when the discussion I hoped for was brought out. For my own benefit I wish to see more light on the subject.

"The problem arose when we had a built-up frame of structural shapes, supported at several points and loaded at a known point: Required the reactions at supports. It was discussed by several designers and engineers, with the result as I gave it. During the discussion the claim was made that the problem was indeterminate, but that did not satisfy us, since the same reactions, if measured, would appear at each application of the load, and these reactions we wished to find, because we were up against an actual case in iron and steel, and not engaged in a fine-haired scientific discussion.

"While therefore agreeing with Mr. Graham that 'only three points are required to support a plane,' we had to look conditions in the face and could not dismiss the subject by saying that 'if more are used the division of the load is arbitrary,' because if placed by an arbitrary system, that system was not of our making, and we had to find the reactions existing, not those resulting from some arbitrary arrangement of our own. We realized that the method is only absolutely correct with a perfectly rigid body, but found no way of introducing a correction for deflections, short of a very arbitrary way, which might or might not (probably not), be in accordance with the way that nature had distributed the reactions in our particular frame. We tried, as suggested by Mr. Myers, to avoid the construction that gave rise to our troubles, but could not do so. I think Mr. Graham has not entirely made out his point in distributing the reactions. He says the particular four-armed spider shown is not in equilibrium about rectangular axes, but does not tell us where to place the origin of these axes, nor the direction of the same. Now it seems to me that the geometrical center of gravity of the supports is a point that must be recognized, and it logically becomes the origin of these rectangular axes. The direction of the axes is determined by the direction of the line joining the center of gravity of the load with the geometrical center of gravity of the supports. At any rate, as far as he goes up to this point, I have as much right to claim these as the rectangular axes as any other, and I think I am right in so doing. If this point is granted, then his spider would not be in equilibrium, while mine would. Later he *assumes* the origin at *B* with *O B* as direction, but why? It is unfortunate that I chose a four-armed spider as my illustration, since it gives Mr. Graham an opportunity to divide the load in a manner seemingly impossible with a spider of uneven number of arms, and I should like to ask him to extend his method to a spider having five arms. Mr. Graham's treatment of the subject after he has obtained his reactions seems particularly good, and is a point worth bringing out.

"I should like to see a thorough discussion of this problem, and if any can throw light upon it, I hope they will do so.

"C. F. BLAKE."

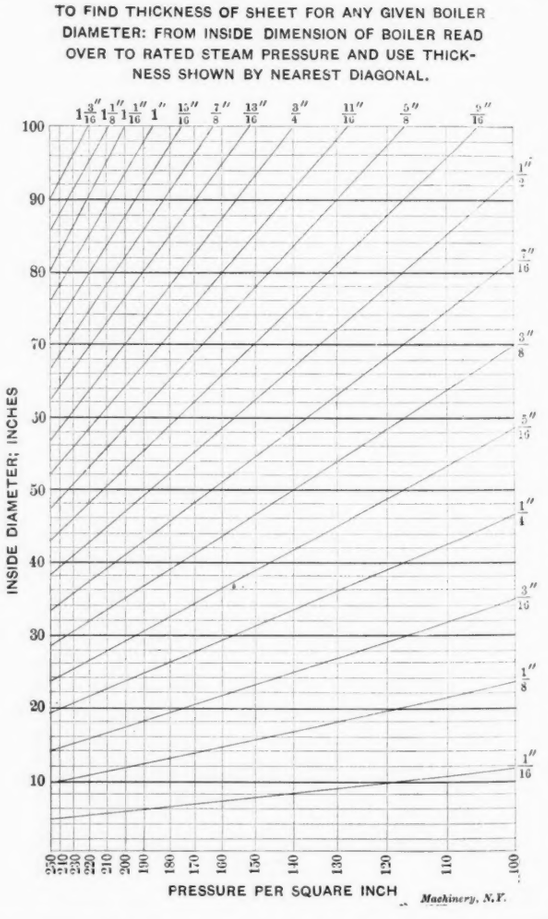
* * *

One of the useful applications of the electric motor is the operation of large valves. In the modern steam plant many of the valves are of such large size that if manually operated, two men often must be employed, and the closing or opening is slow. When electrically operated all the important valves can be wired so as to be under the immediate control of one operator. In emergencies a fraction of a minute lost in the closing of a main steam valve may mean all the difference between a trifling accident and an appalling disaster. A little wrinkle in the application of the motor to large valves, as practiced by one large electrical concern, is arranging the reducing gearing so that the motor can attain full speed before the valve begins to open. In this way a hammer blow is struck that does not fail to "crack" the valve disk loose from its seat; if the valve were made to open with the starting of the motor, frequently its torque would be insufficient to start it loose, although ample for opening it after the initial movement had been accomplished.

* * *

BOILER SHELL CHART.

The accompanying chart, contributed by Mr. A. A. Kellogg, of Green Island, N. Y., gives a graphical means of finding the thickness of boiler shell material for the cylindrical portion of locomotive or other type boilers, when the diameter and steam pressure are known. It is laid out to give a nominal factor of safety of 6, with steel plate having an ultimate tensile strength of 55,000 pounds per square inch of section. The ordinates or verticals represent boiler diameters, in


TO FIND THICKNESS OF SHEET FOR ANY GIVEN BOILER DIAMETER: FROM INSIDE DIMENSION OF BOILER READ OVER TO RATED STEAM PRESSURE AND USE THICKNESS SHOWN BY NEAREST DIAGONAL.
INSIDE DIAMETER; INCHES
PRESSURE PER SQUARE INCH
Machinery, N.Y.

inches, and the abscissæ or horizontals, the boiler pressures, in pounds. By tracing the horizontal line from any given diameter to its intersection with the vertical for the given boiler pressure, the thickness of steel plate required may be read directly at the upper end of the nearest diagonal. For example, what thickness of plate should be used for a boiler shell 80 inches diameter, carrying a pressure of 160 pounds per square inch? The intersection of the 80-inch diameter horizontal and the 160-pound vertical coincides with the diagonal representing 11-16-inch plate, which is the thickness required. Of course, steel-plate of this thickness and 55,000 pounds tensile strength would not make a boiler having a factor of 6, for the reason that the longitudinal seam is necessarily weaker than the solid plate, but such seams are now easily made over 80 per cent. efficiency, so that we can safely count on a factor of 5, which is the one commonly accepted.

* * *

THE PRACTICAL INSPECTOR.

E. N. PERCY.

E. N. Percy.

The inspector's duty is to represent his employer, and see that his employer's conditions are complied with in the most approved manner. The engineering inspector holds a responsible position, and should be, and usually is, a man of long experience and sterling character. Whether he is inspecting materials, construction, plants in operation, or steamships, he must be a specialist in his particular line in order to properly represent his employer.

Inspection begins with the raw product. Pig iron is tested by chemistry and with the microscope. It is broken, that the inspector may observe its texture, and crystallization; also, that he may note the amount of free graphite and carbon sprinkled through it. For first-class castings he should not pass any pigs full of dirt or slag. The proper mixtures of the various irons for a given class of castings must be personally seen to on any large or important work. In the manufacture of steel for forgings, castings or tools, the blistering or puddling processes are noted, and the inspector sees that all coupons for chemical and physical tests are cut actually from the rails or billets or sections they represent, and that said coupons suffer no subsequent "doctoring," tempering or annealing.

In all Bessemerized steel, he will see the blow at the converter, note that it is oxidized clean, until all colors disappear and white flame appears. He will have coupons made on important castings, and have buttons for chemical analysis cast from the same blow. He must see that these button molds are not filled with slag, or melted clay or flux instead of steel. He should also see that large castings are properly cooled, so as to have the least possible internal strain. With rolled sections, forgings and plate work, there are apt to be laminations, where scale or carbon has interfered with the welding of the different parts of a section.

Copper pig requires only the most superficial inspection, as it never contains visible impurities. Chemical analysis may show traces of silver or gold, which can do no harm. If, however, it is found to contain zinc or tin, it should not be used near salt water, without certain precautions to prevent galvanic corrosion. Tin, zinc, antimony and lead can be accepted as generally sold unless required especially pure for some particular reason. Commercially pure metal, while answering most purposes, may cost many times as much if required chemically pure.

E. N. PERCY was for a time employed in the machine shops of the Vance Mill & Lumber Co., and then attended the Lick Technical School for three terms, taking the mechanical and scientific studies. For two years he went to sea as a junior engineer, then for two years he was with the Geo. E. Dow Pumping Engine Company as designer. He also worked for one year, as designer, for the Union Iron Works. Since then he has been inspector of machinery for the United States Government. Some of his more important work has been in connection with designs for the steamship *Whittier* and the battleship *Ohio;* for the San Francisco Gas and Electric Co.'s plant; and some hydraulic work.

The inspection of crude oil is a specialty not to be treated here, except as a fuel; but of its finished products in the lubricating line, we will speak later. An oil which has a specific gravity of .926 at 60 degrees F. and a flash point of 260 degrees F. will burn nicely with a little warming, and be perfectly safe. The flash point should not be below 180 degrees or better, 200 degrees. Beaumont oil, by one analysis contains 83.26 per cent. of carbon, 12.41 per cent. of hydrogen and 3.83 per cent. of oxygen. This may be considered a very rich oil, and will give 19,481 B. T. U. per pound. To test for flash point, warm up a thimbleful with a thermometer in it, and note at what temperature it can be lit with a match. This should be done very quickly, or the more volatile gases will ignite first, giving an imperfect result.

To select good coal, wherever it may come from, choose the hard, shiny lumps, whose dust shines like diamonds when dry, and do not select mushy, soft, dull coal that smells of bitumen or heavy oil.

Next, after raw products, the inspector has to deal with the finished, or partially finished article. All castings require careful inspection. Look in all angles and fillets for cracks. If the iron suddenly changes thickness, test with hammer to see if the iron sounds strained. Note if workmanship is good, and if it is properly annealed or chilled, as the case may be. See that the iron has run well together at all points. Sometimes the iron will "freeze" and not come up well somewhere. There are often stream lines in cases where the iron has run, but was cool, and welded imperfectly. The casting should be of even thickness where intended. If a very tall casting, the head of iron is apt to compress the sand at the bottom and make the iron thicker there. Also, the cores will sometimes shift, or float. If chaplets are permitted, they should be tapped, to see if loose. They should be properly calked, if leaky, and should be so inserted that their edges are covered and hidden by the metal. Chaplets should be tested very carefully. The writer has in mind an over-zealous inspector who tapped on a chaplet until it was so loose it could not be fixed, and in removing it, the casting was ruined. The casting was worth many hundred dollars. Bronze and brass castings are apt to leak in cases where one crucible is poured in, and then another, and so on, where the casting is large enough to require several crucibles of material. The joining lines of these "pours" can always be seen. They may assume the appearance of a thin scale, and such "scale" on bronze castings should be very carefully examined.

Ribs and ties should be carefully tapped with a light hammer to ascertain any difference in tension. Spongy spots should be carefully considered in regard to their location, etc. If, as is an excellent plan, the more important castings are tested by hydrostatic pressure, they should be tested at about 50 per cent. more than their maximum working pressure. Wherever a fine sweat appears, that part should be marked with chalk, and pened inside until it leaks no more. Should the leaks be numerous, and fine streams of water appear in many places, and the casting show signs of distress, it must be rejected. No internal shellacing, oiling, or plugging should be allowed previous to the test. Some builders resort to many tricks in these tests. They use heavy oil, instead of water, because it will not come through defective iron so easily. They cut out defective parts of castings, and insert plugs. One worthy ran the pump pipe straight through the casting to the gage prominently displayed on top. He filled the casting with water, pumped up the gage and called the inspector. The inspector thought the gage was remarkably responsive to the pump, and called an investigation. The worthy gentleman explained that "he meant to put a hole in the pipe, but forgot to." The inspector should always see that there is a "hole in the pipe."

Castings should be carefully measured, tested for roundness or straightness, and their squareness to other parts of machinery noted. Forgings are inspected for flaws, cracks, imperfect welds, burns, temper, springiness, and the coupons tested for strength. Each large forging should have two coupons taken from it—one for bending test, and one for tensile—and the inspector must see that these are not subjected to any treatment subsequent to their removal from the forg-

ing. Plates should be examined for laminations, cracks, blisters, buckles, thickness, scale, and general condition. Plates are apt to show cracks around punched rivet holes, or sheared edges. A blister should be drilled into, and, if merely a buckle, it can be planed out, but if laminations filled with scale show up, the plate must be rejected, unless the blister can be cut out. If plates are pickled, tempered, or put through any other process, it should be carefully noted, as more depends upon plates, and they carry greater loads in comparison to their capacity, than any other material of engineering.

The inspector himself should see all bronzes and babbitts for important castings compounded and melted. He will be present when the larger bearings are fitted, and note the oil grooves and holes and provisions for lubrication.

Coupons from forgings, castings, and plates for bending tests, shall be ½ x 1 inch by 8 or 10 inches in length. They can be bent in any hydraulic press to a radius whose length shall be determined by the qualities the metal should have. Coupons for tensile strength of iron castings and steel are round, ½ inch diameter by 3 inches long, with enlarged screw ends for testing machine. At 1 inch each side of the middle a center punch mark will be made. From these, the elongation after rupture can be measured. The reduction of area is also noted, and the number of pounds to break the coupon. This latter is changed by computation to pounds per square inch.

Boiler and machine steel run about 65,000 pounds per square inch. Nickel steel runs from 95,000 to 105,000 pounds per square inch, with 25 per cent. elongation, and 15 per cent. reduction of area. The requirements for steel change continually, and the inspector must obtain this from experience, study, instructions or specifications.

An inspector of foundations must see that the piling is full length, and driven without splintering, that the spring mat, rubble and cement are of the proper kind, that the cement contractor places the foundation bolts according to the template, and that the template is according to the engine. The foundation should be dry, and the flywheel or armature pit should have an accessible trap to sewer, with stairs down to it, if possible.

Probably the most important duty given to an inspector is the inspection of an elevator or a steam boiler, because they concern human lives. For a new boiler, it is merely filled with water, pumped up, and tested at 30 to 50 per cent. of excess pressure. If no rivets or seams leak, and stays and tubes are all sound, the boiler is emptied, and the inspector enters to sound the stays, to see that the calking tools have not grooved the plates, and that the boiler is free from mud and oil. The first time a boiler is steamed up, he sees that no oil or grease gets in from the condenser during the trial; that all rivet holes are drilled, not punched; that holes for tubes all flare properly, and that no cracked, split, or crooked tubes are used. The calking must be done by *upsetting* the corner of the plate, *not* by *splitting*. The grate bars must be suited to the coal they will burn, and of such shape that they will not warp. The boiler must be well supported, and accurately aligned. Brickwork should never take any of the boiler weight. The safety valve must be tried, its seat inspected, the weight or spring set, tested, locked and a key given to the proper party. In an old boiler, additional inspection as follows is required. 1st. Internal, for corrosion, scale, loose stays, burns, pockets, mud and thickness of metal.

2d. External, for rust, strength of supports, thickness of metal, ends of tubes, interior of furnaces and stacks. Water gages must be inspected and tested, also gage cocks. The steam gage must be calibrated, and there should be at least two ways of feeding the boiler.

3d. For all special requirements of the employer whom the inspector represents.

To inspect an elevator, first note the condition of the cables—how many ends are sticking out, how worn it is, how its terminals are secured, and how many there are. Then the sheaves should be carefully inspected. Any sheave that has a piece of the flange gone, larger than half the section of the cable, should be condemned as dangerous.

Sheave bearings and axles come next; then the motive power. If rams, see that all work smoothly. Look at the cup leathers, note if they are new, and if there are plenty on each ram. If electric, look at the worm gears, or screw, and see that neither wears too much in one place. Engineers are very apt to set up the driving nut so tight on the worn part of the screw, that when the nut reaches the newer part of screw, the ball bearings are crushed, and the elevator locked between floors.

The regulating devices must also be carefully inspected. See that the ropes are not worn, that the rheostats swing easily, and, in the case of a hydraulic plant, note the condition of the regulating valves, that they move easily, and that the main valves do not leak. The governor should be set properly, and given a thorough test at full speed.

The pumps or dynamos should be inspected to ascertain their condition and means of regulation. The air chambers, compensators, shock plungers, etc., should be carefully looked after. All elbows and tees carrying high pressure water must be thoroughly tested with a prick punch and hammer to see if the high velocity has cut them dangerously thin.

The safety appliances must be tried as nearly as possible under actual conditions. With air-cushion machines, they should at least once a year be dropped from the top of the building to test the cushion. It is not advisable for the inspector to ride during this test, but he might invite the maker of the elevator to do so.

The inspection of wood for engineering purposes is a specialty belonging to the expert lumberman, but an inspector can assure himself that it is of good quality, straight grained and free from knots. If it is chosen for lagging, he need look but for beauty alone.

He must learn to know the good and bad qualities of paint, varnish, oil, lubricants, glass, packing, tools, rubber, pumps, stokers, auxiliary machinery and all supplies for the engineer. This comes only from experience and wide reading.

The inspector is made use of and employed by insurance companies, buyers of machinery, steel companies, governments, navies, and all who buy or build machinery.

* * *

One of the strange features of mining is the existence of subterranean fires that have raged in abandoned coal mines for many years. One of these burning mines is the Greenwood Colliery, near Wilkesbarre, Pa. It has been burning for nearly fifty years and, so far, has resisted all attempts to quench it. Flooding with water is not effective, partly because the burning vein is above the natural water level, but largely because the imprisoned air and gas prevent the water reaching the fire. A determined effort is now to be made by the company to quench the fire, and drill holes have been bored, through which water charged with culm will be pumped in in vast quantities. The culm fills the vacant spaces of the mine, although the water may escape, and being wet it smothers out the fire. It also hardens in time, forming a mass practically as a solid vein of coal, and in this way the roof is supported so as to prevent the cave-ins which are a disastrous feature of these subterranean fires, especially in settled sections.

* * *

Referring to the model of the new quadruple-screw Cunard steamers exhibited at the Louisiana Purchase Exposition a correspondent of the *Scientific American* says: "Of course the model that attracts the most attention is that of the new 25-knot, 40,000-ton turbine steamers. . . . For reasons which can well be understood in this age of keen competition, the company has not seen fit to place upon the placard of this model any of the dimensions, etc." Certainly not! If the company had been so unwise as to put those dimensions on a placard where all the public could have seen them, every Tom, Dick and Harry would be building 25-knot turbine steamers and thus put the old established steamship companies out of business! As a matter of fact there is a lot of popular nonsense believed about business secrecy and the value of ideas. Ideas and knowledge are of little value unless they have the backing of capital and business push.

* * *

The index for Volume X of MACHINERY, (1903-4) is now ready and a copy of it will be sent to any subscriber requesting same. In writing please state whether the Index for the Shop Edition or the Engineering Edition is desired.

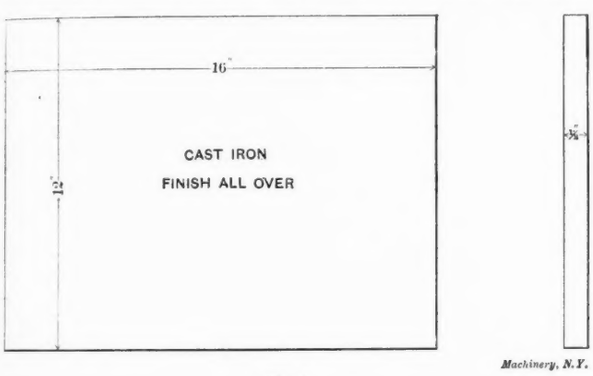
ESTIMATING COST, WITH EXAMPLES ILLUSTRATING APPLICATION OF METHOD.

JAMES A. PRATT.

James A. Pratt.

In the March issue of your journal I note an inquiry for methods of estimating cost, and offer the following as a good method, provided one has a knowledge of the work from the shop standpoint. If not he can hardly expect to do much in the way of estimating, in spite of the fact that many practical shop men are not good judges of time required to perfrom work.

The complete estimate of the cost of a machine will require an examination in detail into the cost of all the separate items such as patterns, castings, forgings, steel or brass rods, bolts, screws, etc., the various machining operations, and finally the cost of running the shop, offices and other fixed charges. If a number of similar machines are to be built, the cost of the patterns will not be so prominent an item as where only one is to be put up, in which case it may form a large percentage of the total cost. The estimating of the cost of patterns will require the cost of lumber and all other materials which enter into the construction of both patterns and core boxes as well as the cost of labor; and a knowledge of the men and their ability, as well as the machines that are available is of importance to the one making the estimate. He must also have a knowledge of pattern work, and should be able to decide as to the most economical meth-



Machinery, N.Y.

Fig. 1.

ods in this line. Each operation must be gone over carefully in the mind, such as sawing, turning, planing, trimming, gluing, filleting, etc., and the more minute the examination the more accurate will be the estimate. It will be a good idea to note whether the methods in mind when making the estimate are being carried out in the shop; and if slower ones are used a change should be made, for it requires eternal vigilance on these points to keep a shop up to date.

Next to the patterns will come the castings, and of these we will require as many sets as there are machines to be built. The weight of castings must be calculated and is readily obtained from the drawings by dividing each part into simple geometrical form, getting their volumes and from this estimating the weight. Almost all machine parts can be divided into a combination of forms of this sort and easily computed. This may be done in several ways by approximate methods, which save time and give results near enough for all practical purposes. Methods of estimating weights would, I think, be a subject well worthy of attention from contributors, but nothing of that sort is here offered, as the object of this article is confined to methods of estimating cost. After calculating the weight of the castings about 10 or 15 per cent. should be added for errors, finishing, etc.

On machine work the same process is followed as in the pattern estimate; that is, each operation must be gone over in detail, such as drilling, turning, boring, tapping, planing, etc., as well as a consideration of the time it will take to set a piece on a machine. Of all these except the setting a very accurate estimate may be obtained by calculating. Take turning a certain portion, for example. We know the surface speed that may be run, as well as the feed per revolution and the length of the piece, so can easily calculate how many chips will be taken to finish; hence, by a little figuring we may get a satisfactory result. The same is true of all other machine operations, but when we come to the setting up it must be entirely a matter of judgment.

A very important thing in working up an estimate, especially of machine work, is to see what special tools are available, and whether or not any new ones must be made; for if so, these must be reckoned in with the job, since it is desirable to clear a profit over all expenses. If a new tool to be made is one which can be used for general work after the job is done, we may be a little lenient and permit a part of the cost to be entered against the shop equipment; but the job directly in hand should bear the brunt of the burden of new special tools. Each tool should be considered as working at its maximum rate, and the work placed on each machine to the best advantage; that is, a job which can be done most advantageously on a turret lathe should not be put on an engine lathe, and one which can be placed to best advantage on a horizontal boring mill should not be put on an upright. At the present time the high speed steels should be considered, as a marked economy may be effected on all machine operations by their use; and wherever forged tools are used the high speed steels have a clear advantage.

If each operation is followed in detail, it is a comparatively easy matter to get the time on a job, and too much stress cannot be laid on the importance of going minutely through the making of every part of a machine, and assigning a certain time for each operation. The conditions under which the work will be done should not be assumed too favorable, as more or less time will be spent in looking for bolts, waiting at the tool room, reading drawings, and attending to the machine, all of which things increase the time but do not advance the work. The possibility of accidents should be considered also. I am aware that in some shops estimates are made, and the liability of accidents not considered, but such losses, when they occur, are charged against the profits. I think this should be considered as part of the cost of a job, as when we have made our estimate on the basis outlined the profit will come in as a clear item, and not mixed with any other considerations. The amount added for these things may be a very small percentage of the total cost, since it is covered by a number of jobs, all of which help to carry this burden.

After estimates on patterns, castings, and machine work have been made, take up shop expenses, such as rent, taxes, insurance, supplies, as well as the non-productive labor which must be employed. The running expense of the shop for a day is easily determined, and such an amount should be added as will permit the job in hand to bear its just share of the shop expense. The profit may now be added as a clean quantity, since everything has been considered by itself; and it is quite important that it be so viewed, since if it has to cover items not individually considered, one is very apt not to make it large enough, and the contract becomes a losing deal. In the above notes I have assumed that the machine has never before been built in the shop and that the estimate is being made directly from the drawings.

As an illustration, let us estimate cost of pattern, castings, and machine work on three planed bench plates, as shown in Fig. 1. The pattern will probably be made up of a main body and two end pieces, dowelled and screwed together. It is assumed that 1-inch stock is at hand from which to make the pattern.

James A. Pratt was born at Chelsea, Mass., April 6, 1873. He was graduated from school at 16, and entered a business office for two years. He then went to the Providence Engineering Works as apprentice and served four years. During this time, under the direction of a tutor, he took the regular course in mechanical engineering as offered at Brown University. His experience has covered the building of engines in the shop; erecting on the road; machine tools; special machinery; and jigs, fixtures and fine tools. At present he is instructor in machine work and mechanical drawing at the Sockanosset School for Boys, Howard, R. I. Mr. Pratt is a senior member of the Providence Association of Mechanical Engineers, and has contributed to several technical journals.

Getting out and sawing lumber	10 min.
Trimming ends	5 min.
Getting out end pieces and placing same	20 min.
Finishing pattern	15 min.
Surfacing cuts on different pieces	10 min.
Total working time	60 min.

This allows for actual working time only, but there will be more or less time indirectly spent which we must consider. To cover this, call total time on the whole job one hour and thirty minutes, which at 28 cents per hour equals 42 cents.

Next come the castings, of which three will be required. Proper allowance having been made in the pattern for shrinkage and finish, each plate will be 12¼ inches × 16¼ inches × ¾ inch. Taking ¼ pound as the weight of one cubic inch of cast iron, which is sufficiently accurate in this case, the calculation of the weight is readily made as follows:

$12\frac{1}{4}'' \times 16\frac{1}{4}'' \times \frac{3}{4}'' \times 3 \times \frac{1}{4}$ lb. = weight of three plates or $\frac{49}{4}'' \times \frac{65}{4}'' \times \frac{3}{4}'' \times 3 \times \frac{1}{4}$ " = $\frac{28665}{256}$ = 112 lbs.—say 115 lbs., which at 2 cents per lb. will cost $2.30

Considering now the machine work. We have a plate 12¼ inches wide, 16¼ inches long and ¾ inch thick to reduce to 12 × 16 × ½. Assume that we take one rough and one finish cut with a roughing feed of 1-16 inch and a finishing feed of ½.

Since plate is 12½ inches wide and we take 1-16 inch at each cut we will need 12½ inches ÷ 1-16 inch, i. e., 200 cuts, and as each cut is 16 inches long the planer bed must travel 200 × 16 = 3,200 inches to get over the surface once. It must also travel the same distance for the return.

Speed of planer on cut 24 feet per minute = 288 inches.

Return of planer 48 feet per minute = 576 inches.

Hence we have need for cuts $\frac{3{,}200 \text{ inches}}{288 \text{ inches}}$ or 11.10 minutes and as the return speed is double the forward—one half as much time will be required for the return. Let us call the time for the cut 12 minutes and for the return 6 minutes. Now the planer will take some time to reverse at each end of stroke and for this we will allow 7 minutes. Cutting on sides of plate will require 3 minutes, with two minutes each for reverse and return, making 7 minutes for sides. Cuts on ends of plate will take one minute each for reverse and return, or three minutes for the ends, which makes a total for roughing cuts on one face and all sides, of thirty-five minutes; and as we have this on three plates, 105 minutes will be required for roughing one face and all sides and ends. We must also surface the other face of the plates at 19 minutes each, which makes 57 minutes more, or for roughing cuts throughout, 162 minutes. For finish cuts on all faces and ends we have, using the same method of figuring surface, but ½-inch feed—33 minutes, which makes the total time 195 minutes, or 3 hours 15 minutes, which we will call 3½ hours. For setting the first plate in the planer we will allow as follows: Getting and placing rib piece, 10 minutes; setting work, 10 minutes; clamping down, 15 minutes—a total of 35 minutes. For the other two plates we will allow 20 minutes each, as they will go quicker, which makes a total of 75 minutes for all three. For the second face we will allow 15 minutes, and for the ends and sides 45 minutes, which gives a total for setting, for all the roughing cuts, of 2 hours and 15 minutes.

Coming now to the setting for finishing cut we will make allowances as follows: Removing stop plate and clamps and resetting plate, 12 minutes; getting bolts and clamping first plate, 17 minutes; for the other two plates, 10 minutes; for the second face, 15 minutes; a total of 54 minutes—say, one hour. Then we will allow for grinding and setting tools, and adjusting feeds, two hours; and finally for cleaning machine one half hour. This makes 5 hours and 45 minutes for setting grinding tools, etc., which we will call 6 hours. With the 3½ hours for the cutting time we now have 9½ hours. Adding for attention to machine, risk, etc., say, 5 per cent., and we have a trifle less than ten hours.

This assumes that the workman does not stop for any purpose whatever, but is constantly at work. As this is not possible, we may safely add one hour for time spent indirectly on the job, which gives us a total estimated time of 11 hours, which at 28 cents per hour is $3.08, making a total estimated cost of $5.80.

The actual time required to run this job off was 11 hours 25 minutes, showing that I was short on my estimate, but as two of the plates came from the foundry chilled, considerable time was lost in getting the work started, three tools being spoiled and one broken before work was really begun.

The average price for such jobbing work is 50 cents per hour for patternmaker and machinist, and for castings 3½ cents per pound. Calculating on this basis, our estimate would stand as follows:

Patternmaker, 1 hour 30 minutes, at 50 cents	$ .75
Machinist, 11 hours, at 50 cents	5.50
115 pounds castings, at 3½ cents	4.02
	$10.27
Estimated cost	$5.80
Leaving a surplus of	4.47

from which must still be deducted the proportionate part of the general shop expense before referred to, before we get down to the net profit.

As a second illustration of cost estimating, let us take up the cone pulley shown in Fig. 2. The pattern on this job was solid and the core box of the skeleton type. The core box is shown in Fig. 3 in order to make clear the references to it.

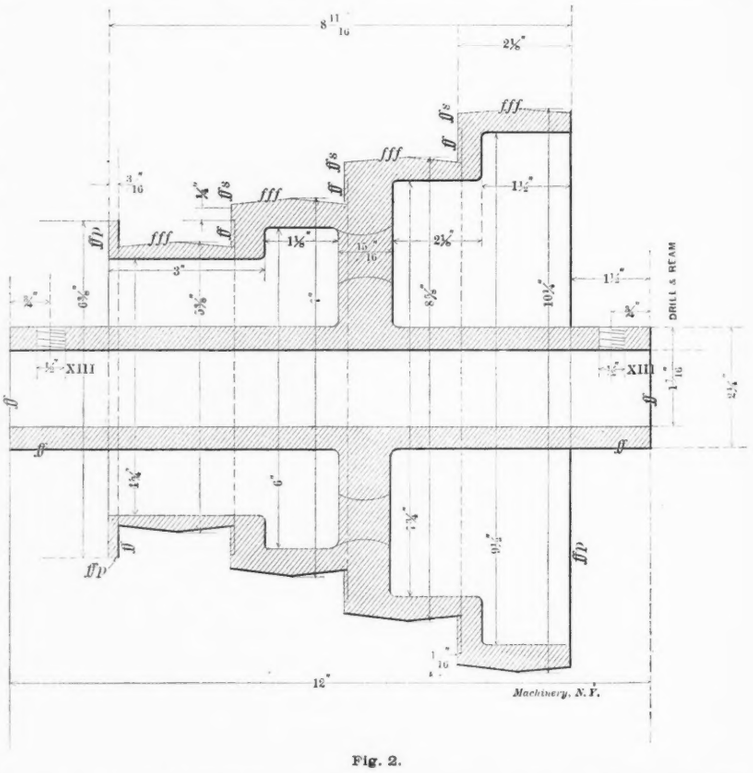


Fig. 2.

The pattern will be made up of a series of disks of ¾-inch stock glued together and turned, and large core prints 1⅜ inches thick must be placed at each end. The flange shown in the drawing is left loose on the pattern for convenience in drawing the pattern from the sand. Estimated by items as below we have:

Getting out and sawing stock for pattern complete	60 min.
Planing up stock	45 min.
Laying out and bandsawing	60 min.
Gluing up	25 min.
Turning small core prints	20 min.
Turning pattern and sanding	60 min.
Placing prints and finishing pattern	20 min.
	290 min.

Total time on pattern, 4 hours 50 minutes.

Indirect time, ½ hour, making 5 hours 20 minutes—say 5½ hours.

Core Boxes.

The small core will be a "stock core," and no core box will be needed. The core for the larger part we will make of the skeleton type and sweep up in four quarters, these being afterward pasted together for use in the mold. Again estimating by items we have:

Getting out sides complete	107 min.
Getting out and attaching ends	25 min.
Getting out and placing barrel	20 min.
Getting out two shoulder pieces	30 min.
Doweling shoulder pieces and baffle board	40 min.
Getting out baffle	25 min.
Shellac	15 min.
Strike board	20 min.
Total	282 min.

Total time on core box complete, 4 hours 42 minutes.

Total time on pattern, 5 hours 30 minutes.

Total, 10 hours 12 minutes.

To cover indirect time, call estimate on pattern and core box 11 hours.

The next thing for consideration is the weight of the casting. We will take the hub as a cylinder 12 inches long, 2½ inches diameter, with 1¼-inch hole through it—44 cubic inches; the central web as a ring 7¾ inches diameter, ⅞ inch thick, and 2½-inch hole—37 cubic inches; the small step as a ring 5½ inches diameter, 3 inches long and a 5-inch hole—11.50 cubic inches, etc., using the same method in getting the whole volume, viz., divide it into a series of rings and get the volume. Adding these together and multiplying by .25 pounds (the weight of a cubic inch of cast iron) the calculated weight is 46 pounds. Add 10 per cent. for errors and variation, and we have approximately 51 pounds. The actual weight of this casting was 52 pounds.

In connection with the machine work, the first thing to be done is to look over the machines in the shop and see if any special tools are needed. This is very important, as at times work may be taken up which is larger than a machine can conveniently handle, and it will be necessary to make some alterations. We find nothing of this sort to be done on this particular piece, but we will need a long arbor, which we will charge entirely to the job. Those who wish might take part of the cost of the arbor off, since it can be used for other purposes after this particular piece of work is done.

Finding we have an arbor 1⅝ inches diameter and 16½ inches long, we will turn it down for this job. Being already centered we will not have to allow for that, so the time will be as follows: The coarsest feed of the lathe to be used is 1-100 inch per revolution, and we will take two roughing cuts with the lathe running 130 R. P. M.

The lathe must make 1,650 revolutions in going the length of the arbor and will take $\frac{1650}{130} = 13$ minutes for each of two roughing cuts, making:

Roughing time	26 min.
Finishing chip at 160 R. P. M.	11 min.
Filing and fitting	45 min.
	82 min.

Total 1 hour 22 minutes. Call this 1 hour 30 minutes.

Coming to the machine work on core, we have drilling at 94 R. P. M., surface speed 35 feet per minute. Piece is 1 7-16 inches diameter = 23-16; 23-16 × 3.14 = 4.5 inches circumference. As the surface speed is 35 feet or 420 inches per minute, and as a point on the circumference travels 4.5 inch at each revolution, we must make $\frac{420}{4.5} = 94$ R. P. M. Feed 1-32 inch per revolution will need 32 revolutions to go 1 inch, and for 12 inches, the length of the hub, we need 12 × 32, or 384 revolutions to go through the hub once, and it will take $\frac{384}{90} = 4 +$ minutes. Call this 5 minutes for roughing and 5 minutes for finishing, we have 10 minutes. This is provided casting comes soft and homogeneous. It may come hard with blow holes, causing grinding of drills, etc., and to cover these possibilities we call

Time	20 min.
Squaring down cone faces	25 min.
Squaring inside of flange face	10 min.
Spotting down to crown size on cone steps	24 min.
Turning cone steps 2⅛ inches long, feed 1-100 inch per revolution, will need 213 revolutions at 22 R. P. M., and will take	10 min.
Three chips on each step, and assume all steps same size, we would need about 120 minutes; but we can speed up on smaller steps and may call	
Time	100 min.
Undercutting on cone faces	30 min.
Squaring and turning left side of hub and flange	15 min.
Scraping, filing and polishing	85 min.
Drilling and tapping for setscrews	20 min.

The above deals only with the actual cutting time. We must now take into account the setting and grinding of tools and other incidentals.

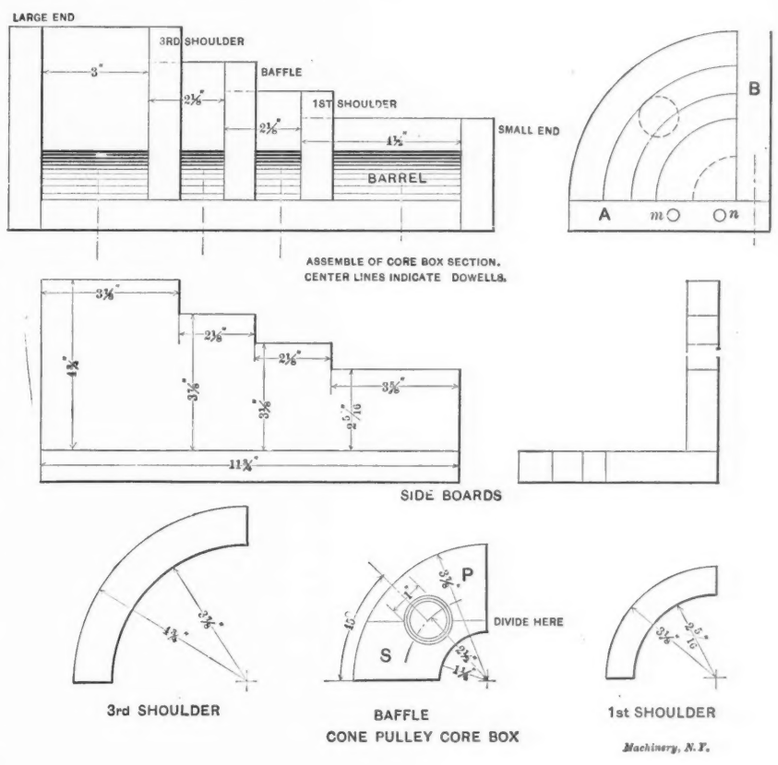


Fig. 3.

Getting out chuck, placing cone, truing up, getting drills at work, changing same, removing chuck and drills, returning tools and getting cone on centers ready for turning, say	55 min.
Grinding and setting tools for squaring faces, spotting cone steps, crowning, undercuts on faces, ends of cone, and setting taper attachment	137 min.
Allow for indirect time	60 min.
A helper will be needed for a short time on this job, and we	
Add half an hour workman's time	30 min.
Cleaning machine	15 min.
Making altogether	711 min.
To which we will add	
3 per cent. for risk, attention to machines, etc	21 min.
Giving a total of	732 min.

Or 12 hours 12 minutes, which we will call 12½ hours.

The actual time on this job in the machine shop was 11 hours 30 minutes.

Combining the items, we have as the total estimated cost:

Patternmaker, 11 hours, at 28 cents	$3.08
52 pounds castings, at 3 cents	1.56
Machinist, 12½ hours, at 28 cents	3.50
	$8.14

Castings of this sort in small lots will sell at about 4 cents per pound, and calculating on this basis our estimate would be as follows:

Patternmaker, 11 hours, at 50 cents	$5.50
51 pounds castings, at 4 cents	2.04
Machinist, 12 hours 30 minutes, at 50 cents	6.25
Total	$13.79

The same items mentioned in previous case must be considered here before profit appears.

It will be noted that the surface speed was calculated for the drilling operation; but this was done simply as an illustration, and is entirely unnecessary in practical work, as tables are published which give surface speed for diameters making certain number of revolutions per minute. One very convenient table which the writer has used was published with the May number of MACHINERY in 1903.

There will be noted a slight difference in the dimensions used in estimating weight and those given in the drawing. This is done to allow for stock and variations in casting.

[While the criticism may perhaps be made that our correspondent has not selected throughout his examples at all times the most economical methods of doing the work, his analysis of the various operations in detail is quite careful and complete, and we think well illustrates such problems as small shops with limited equipment are often called on to handle. A large number of our readers, particularly among the younger men, will find the article suggestive and of much value.—EDITOR.]

* * *

NOTES ON ISOMETRIC PERSPECTIVE.

Mr. Robert S. Brown, secretary of the New Britain Machine Co., New Britain, Conn., sends a sheet of data upon the isometric system of perspective, which is reproduced herewith. He says in explanation: The bulletin print of information on isometric perspective has been issued for the drawing room force of our company. This is presented to the men in lieu of the Farrish treatise on the subject, now somewhat out of date. The Honey method referred to, for determining approximate arcs for constructing any proportion of ellipse, is the closest and quickest the writer knows of. It is in such general use among our draftsmen that nothing more than a reference to it is given on the print.

Isometric Perspective.

Based on placing objects, as the cube (Fig. 1), so that the eye is on a line with the diagonal of the cube. Each of the three visible plane surfaces then appear of same size, bounding lines as *A B*, *B C*, *C D*, of equal length, and extending either vertically or 60 degrees from the vertical to right or left. The angle at which cube is tipped to give this is 35 degrees, 16 minutes from horizontal.

It is customary to measure directly upon co-ordinates *A B*, *B C*, or *C D*, using full-sized scale. This makes each dimension of drawing 22½ per cent. longer than it would appear in a true projection of the object in isometric position.

Exact Construction for the Isometric Ellipse.

Draw both center lines *A C*, *B D*, and the circumscribing rhombus (Fig. 2). From point of rhombus at *A*, erect 45 degree line. A circle with center at center of rhombus and radius tangent to 45 degrees line, will, when continued across center line of rhombus, give major axis of ellipse. The minor axis can be found by 30 degree lines *E F*, *G H*. Isometrical diameter lines *J K*, *L M*, give four other points on the ellipse, and more if desired may then be located by any of the well-known methods.

Approximate Construction for Isometric Ellipse.

Draw circumscribing rhombus with sides to scale (Fig. 3). With center at *B* and radius of circle tangent to *A D*, at its mid-length, draw the long arc tangent to *A D*, and *C D*. With same radius and *D* as center, draw arc tangent to *A B*, and *B C*.

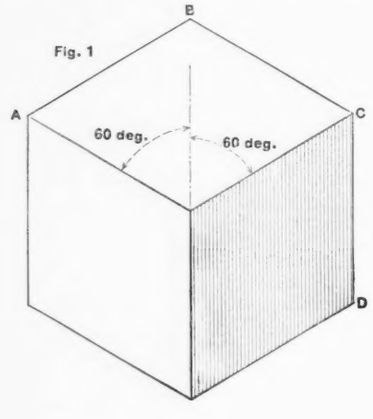
Above construction fixes length of minor axis and will vary from the actual about 0.2 inches to full in an ellipse of 10 inches major axis. Sweeping minor axis so found across major axis, gives approximate location of centers, which will finish the ellipse. These centers will be a trifle outside of the circle, but error may be neglected in small work. A close approximation to length of major axis (making same about 0.06 inch too full in 10 inches length) is had by taking ¼ of co-ordinate *A B*, and sweeping it across major axis with *A* as center.

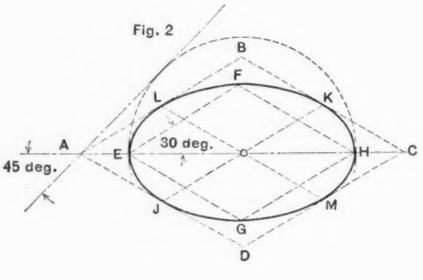
This is useful in locating ellipse from the perimeter rather than center (see Fig. 4), for construction of tangent ellipses of same size.

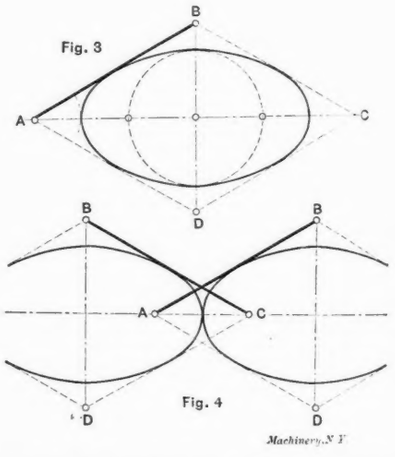
If closer results than the above are required, use method in Fig. 2 for actual major and minor axis, and construct ellipse on the Honey plan. (See Kent, page 47, 5th edition.)

Proportions of Isometric Ellipse.

Isometric Diameter.	Major Axis.	Minor Axis.
1.0000	1.2247	.7071
Log. .00000	.08805	$\bar{1}$.84949
.8165	1.0000	.5774
Log. $\bar{1}$.91195	.00000	$\bar{1}$.76144
1.4142	1.7321	1.0000
$=\sqrt{2}$	$=\sqrt{3}$	$=\sqrt{1}$
Log. .15052	.23856	.00000







Machinery, N Y

SOME CASES OF DIFFERENTIAL GEARING.

A. B.

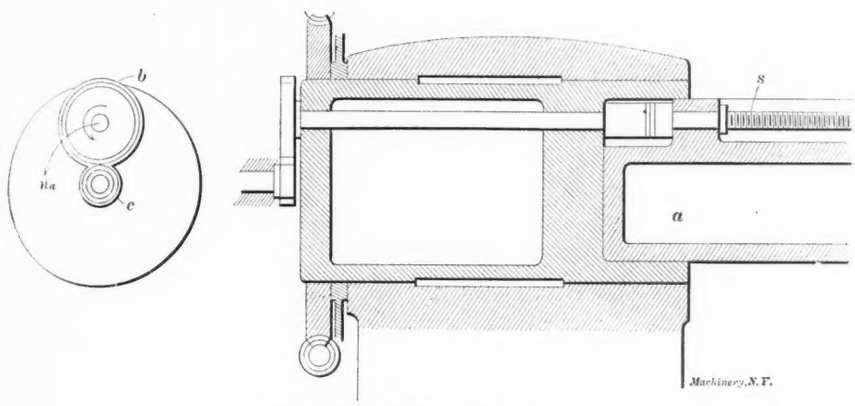
The subject is not a new one but a little study of it, and deriving suitable formulas, will be of interest to those who have not looked into it before.

The principle of differential gearing consists of a gear rotating around another gear, thus creating a ratio. This principle may be used in arrangements which differ in the way the gears are working, giving accordingly different results. Beginning with the simplest one, we take a gear on a crank rotating around another gear, and Fig. 1 (next page) illustrates this case. The bar *a* of a cylinder boring machine carries the feed screw *s* for the boring head. On the end of this screw is keyed gear *b*, which rotates with the bar around gear *c*. Gear *c* is a stationary gear, but as *b* rotates around it,

gear c acts as the driver, whilst gear b is the driven gear. Gear c has t_c and gear b has t_b teeth. Now in order to find the feed of the boring head per turn of the bar, we should know the revolutions of the screw per turn of bar. Instead of the bar making one revolution to the left we may suppose that gear c makes one revolution to the right, whilst the bar stands still. This will have the same effect for the screw. The ratio between gear c and gear b is $\frac{t_c}{t_b}$, so that for one revolution of the bar, the screw makes $\frac{t_c}{t_b}$ revolutions and for n_a revolutions per minute of the bar, the screw makes

$$n_s = n_a \times \frac{t_c}{t_b} \text{ revolutions per minute.} \qquad (1)$$

Gear b and with it screw s turns in the same direction as bar a.



Some Cases of Differential Gearing.

Example: Let the pitch of screw s be 1-3 inch and the feed of the boring head per turn of bar 1-12 inch. This means that the screw makes one-quarter of a turn for one turn of the bar. Then the ratio in the gears is

$$\frac{1}{4} = \frac{t_c}{t_b}$$

Another case is when gear c is connected to the main drive of the machine and therefore revolves too.

Then two considerations are possible: that gear c revolves in the same direction as the bar or against it. See Figs. 2 and 3. When c rotates with bar a, so are the relative rotations per minute of b around c, $n_a - n_c$ and the revolutions per minute of the screw

$$n_s = (n_a - n_c) \times \frac{t_c}{t_b} \qquad (2)$$

Screw s turns in the same direction as bar a if $n_a > n_c$; and in the opposite direction if $n_a < n_c$. In the latter case n_s has a negative value.

Example: As before the pitch of the screw is 1-3 inch and the feed per turn of bar is 1-12 inch but c makes 4 revolutions per minute and bar a makes 2 revolutions per minute. Gear c revolves in the same direction as bar a.

Question: What is the ratio for the gears c and b? For one turn of bar a, the screw has to make one-fourth of a turn, and therefore the number of revolutions per minute of the screw is

$$n_s = \frac{1}{4} n_a$$

From formula (2) we get

$$\frac{t_c}{t_b} = \frac{n_s}{n_a - n_c} = \frac{\frac{1}{4} n_a}{n_a - n_c} = \frac{\frac{1}{4} \times 2}{2 - 4} = -\frac{1}{4}$$

The negative value of this ratio shows us that the screw revolves against the direction in which the bar turns.

The other consideration of this case was that gear c revolves against bar a, and the relative rotation of gear b around gear c is then

$n_a + n_c$. See Fig. 3.

Herewith are the revolutions per minute of screw s.

$$n_s = (n_a + n_c) \frac{t_c}{t_b} \qquad (3)$$

and the screw revolves always in the same direction as bar a, because n_s has always a positive value.

Another arrangement is shown in Fig. 4. The driving member in this case is a cone pulley which carries a stud with a couple of gears running loose on the stud. These two gears f and g, however, are keyed together and the stud rotates with them around the gears e and h. Gear e is fixed to some part of the frame and gear h is keyed on shaft i. The cone pulley d runs loose on shaft i.

The question here arises: How many revolutions does shaft i make for one revolution of the cone pulley? The problem is a little more complicated, as we use here four gears. In order to make it well understood we will take first the four gears have an equal number of teeth. Further, instead of revolving the cone pulley once to the left around the fixed gear e, we suppose this gear to turn once to the right whilst the cone pulley remains stationary. Then through e, f and g—h will make one revolution and, like e, to the right. But the gears on the stud were not stationary and they made one revolution around gear h to the left, with the result that gear g rolled off on gear h instead of turning the same. In other words, h makes one revolution less than the ratio between e and g would indicate. Now if the gears are not all equal we reason in the same way. Suppose gear e makes one turn to the right instead of the cone pulley d making one turn to the left, and the latter remains stationary, then gear h makes

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} \text{ revolutions.}$$

This, however, is not so, as the stud rotates around gear h and as before, gear h makes one revolution less or

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1 \text{ revolutions.}$$

t_e, t_f, t_g and t_h indicate the number of teeth of the gears, and for n_d revolutions per minute of the cone pulley, shaft i makes

$$n_i = n_d \left(\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1 \right) \qquad (4)$$

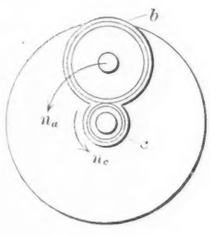


Fig. 2.

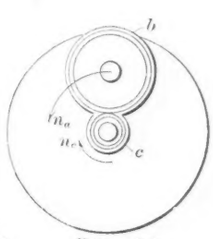


Fig. 3.

Shaft i rotates in opposite direction to cone pulley d if

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} > 1$$

Shaft i rotates in the same direction as the cone pulley if

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} < 1$$

In the latter case we see that n_i has a negative value indicating that shaft i and cone pulley d turn in the same direction and in the first case the sign for n_i is positive, indicating opposite directions.

Thus far, gear e was a fixed gear and the cone pulley with the stud only, the rotating member. Now let us examine the

case when both gear e and cone pulley d rotate. Gear e is then keyed on shaft k, by which it is driven.

We first take gear e revolving in the same direction as the cone pulley and the question is now: What is the ratio between shaft k and shaft i? We split this case in two and observe the results which we get for one revolution of d with e fixed, and for one revolution of e with d fixed, and after this we add the two results.

One revolution of d with e fixed gives us as above

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1$$

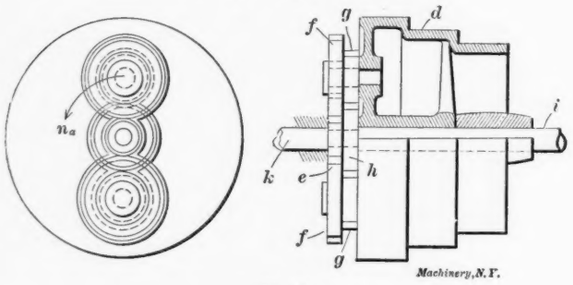


Fig. 4.

and one revolution of e with d fixed gives us

$$-\frac{t_e}{t_f} \times \frac{t_g}{t_h}$$

The value of this must be taken negative because gear e revolving in the same direction as cone pulley d forces shaft i to run in this direction also. The two results added give us

$$\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1\right) - \frac{t_e}{t_f} \times \frac{t_g}{t_h}$$

Cone pulley d makes $n_d = 20$ revolutions per minute.

Gear e with shaft k makes $n_k = 40$ revolutions per minute and turns in the same direction as d.

Gears e, f, g and h have respectively 12, 28, 14 and 26 teeth.

The number of revolutions per minute of shaft i is then

$$n_i = 20\left(\frac{12}{28} \times \frac{14}{26} - 1\right) - 40\left(\frac{12}{28} \times \frac{14}{26}\right) = -24.6 \text{ revs. per min}$$

The negative sign indicates that shaft i revolves in the same direction as cone pulley d and shaft k.

* * *

A HANDY TOOL FOR LOCATING AND ALIGNING SHAFTING AND MACHINERY.

WM. H. BROOKS.

During a recent pilgrimage into archæological methods of doing things I found a new tool for helping along an old job. It was dug up from the bottom of a tool chest and is intended to be used for lining up shafting, machinery, etc. The tool is simple, accurate and inexpensive, and will beat the work of those millwrights addicted to the use of sticks, stones and strings, not to mention nails, wires and full size "chalk prints" on the floor, as well as a great variety of mental gymnastics that would make Euclid blush with shame and mortification.

The body of the tool, Fig. 1, consists of an inverted V marked A in the cut, about 6 inches long and having at the center a spot b about 2 inches in diameter finished perfectly parallel with the horizontal plane of the inverted V and having one line parallel with the V and one at 90 degrees to it, both passing through the center of the spot. Pivoted at the intersection of these two lines rests a dial, c, graduated to 360 degrees and bearing a suitable form of sights or telescope d, similar to that of a surveyor's transit; this latter of course being parallel to the base of the dial and its sight line parallel to the 0 degree and 180 degree lines. A level, e, integral with the sights or

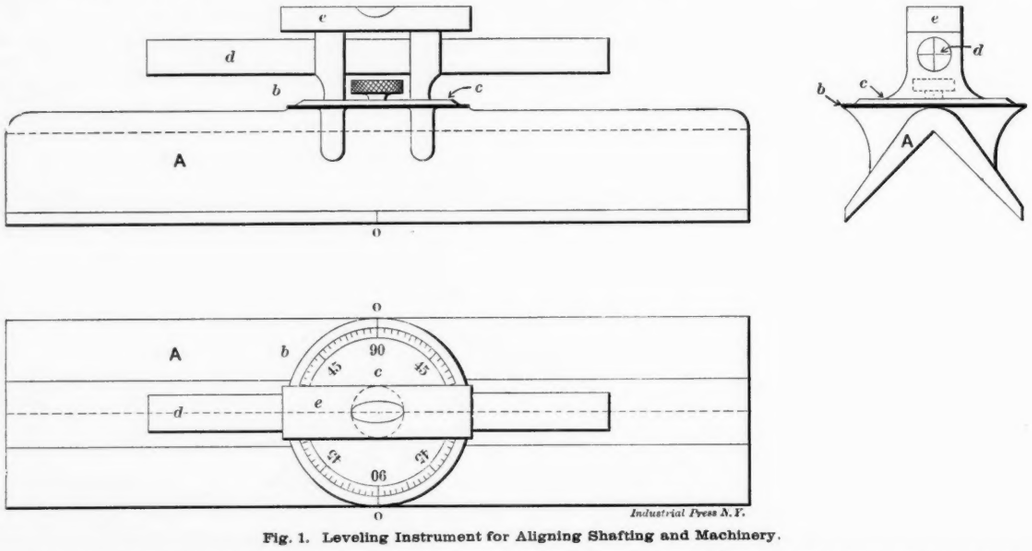


Fig. 1. Leveling Instrument for Aligning Shafting and Machinery.

telescope, and capable of revolution with it about the axis of the dial, completes the tool. A suitable locking device is of necessity added to keep the dial in position. Another detail is the parallel sides of the V, permitting the use of the tool on large as well as small shafts and on which a line o is struck, to correspond with the center of the dial. The form of tool used by the owner was very simple, with poor sights and no glasses, yet a fair degree of accuracy was attained.

With this simple description of the tool in mind we can consider the principle of its operation, which is simpler than the tool.

In Fig. 2, a b is a straight line, on which at any point o erect a perpendicular, and the angles are equal or 90 degrees each. At any point e in this perpendicular line erect perpendiculars e x and e y, then the lines a b and x y are parallel. If we consider the line a b a shaft of any diameter and take a point o and apply thereto the line o on the tool, with the telescope set at 90 degrees, and sight to a point e on another shaft x y, marking points o and e plainly with a scriber or file, and then transfer the tool to the shaft x y with the o on

and for n_k revolutions per minute of shaft k and n_d revolutions per minute of cone pulley d we get for shafts i

$$n_i = n_d\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1\right) - n_k\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h}\right) \text{ revs. per min.} \quad (5)$$

If n_i has a negative value shaft i turns with the cone pulley and shaft k in the same direction; and if n_i has a positive value shaft i turns in the opposite direction to the cone pulley and shaft k.

Now let us see what happens if gear e revolves against cone pulley d. In this case everything is as above except the sign for shaft k, which will be positive instead of negative, because shaft i is forced by the rotation of e to run in opposite direction to the cone pulley and the formula for n_i is

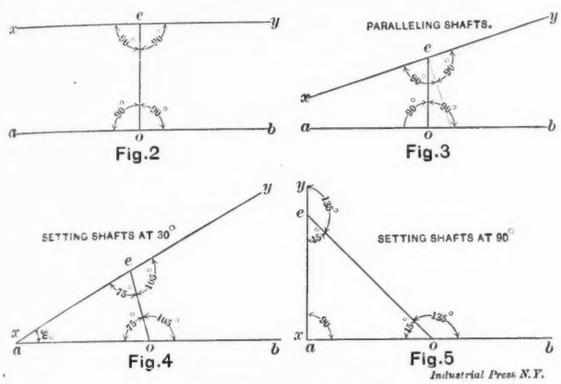
$$n_i = n_d\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1\right) + n_k\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h}\right) \text{ per minute.} \quad (6)$$

If n_i has a negative value shaft i turns with cone pulley d in the same direction but against shaft k. If n_i has a positive value shaft i turns against the cone pulley but with shaft k. Example in figures:

tool and point *e* on shaft coincident and the telescope still set at 90 degrees, any variation of the point *o* from the line of sight proves the shafts out of parallel, as illustrated in the annexed Fig. 3, much exaggerated. Other forms of the principle are shown in Figs. 4 and 5.

When starting to hang a shaft the same method is pursued as in the case of Fig. 2, the line *a b* becoming the engine shaft or line shaft, as the case might be, and *x y* the line of shafting or countershaft to be hung. In the case of short countershafts the hangers can be placed roughly and lined up after the shaft is hung. In the case of long shafts some form of tripod would be of advantage in establishing a long line of hangers or pillow blocks, and the tool again used for a final test. Figs. 2 and 3 are the keys to all these operations. If we wish to extend a short length of shafting already in position we find the location of the nearest or furthest hanger by placing the tool on the end of the shaft and sighting to a plumb line or other target, so the line for all the hangers can be found at once.

Fig. 6 shows an example of a right angle drive, the problem being to determine the position of the mule pulleys, or the driving and driven pulleys. If the position of the mule pulley stand is governed by a beam or column, it is only necessary



Illustrating Principle of Tool.

to sight from the shaft, with the telescopes at 90 degrees, to the rim of the mule pulleys, and the points *o* and *e* thus found become the centers of the driving and driven pulleys. If the position of the mule pulleys is governed by the location of the driving and driven pulleys, the location of the mule pulley center is found by adding or subtracting the mule pulley radius. Here another point is projected on the horizon. A squint tells whether a belt will clear a beam, column or other obstruction, before pulleys are ordered or placed. In Fig. 7 I repeat the examples of Fig. 5, where the shafts are at

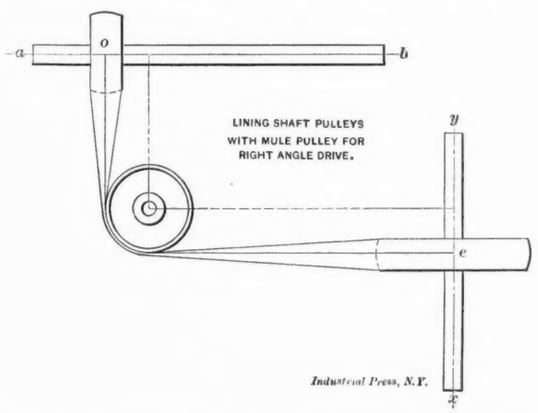


Fig. 6. **Lining Shaft Pulleys with Mule Pulleys for Right Angle Drive.**

90 degrees but do not intersect. The tool is placed on shaft *a, b* at any point *o*, with the telescope at 45 degrees, and the point *e* is found on shaft *x y*; the telescope is moved 90 degrees and placed over *e;* if the point *o* is in the sight line the shafts are at 90 degrees, if not, the shaft *x y* must be moved according to the position of *o* as observed from *e*.

Fig. 9 shows a horizontal and vertical quarter drive. In this case the height of the "sight line" above the center of the shaft must be known. To find this height place the tool on the shaft and sight to a rule, add the dimension found to the radius of the shaft and the sum gives the height above the center as per Fig. 8. To place pulleys in the case of Fig 9, place the tool on shaft *a b* with the telescope at 90 degrees, and note that the telescope be level, sight to the center of the shaft *x y* and mark both shafts: on *x y* the point sighted, on *a b* the point *o* on tool. To point *o* add the *radius* of pulley

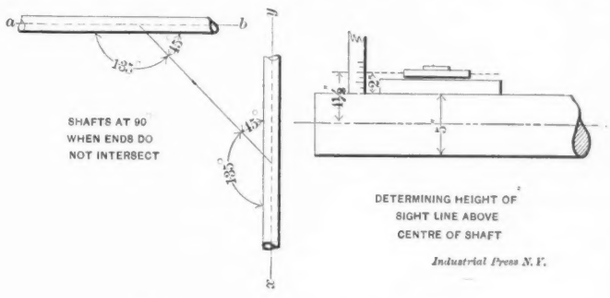


Fig. 7. Fig. 8.

B and to the point on shaft *x y* add the *difference* between the height of the "sight line" (per Fig. 8) and the *radius* of pulley *A*, and the points found are the centers of the driving and driven pulleys. Note that the tool is used but once, with one setting and a small possibility of error, and that the addition or subtraction is governed by the respective directions of rotation, there being four possible positions.

The addition of a cheap tripod and plumb bob dropped through the center of dial permits the use of the tool in place of an expensive engineer's transit, for a great amount of work around the mill, power-house, and in erecting machinery where few tools are available. A string of foundations can be plotted with ease and accuracy and all can be leveled from one position. From one position, such as a certain distance from the walls, the position of engines, dynamos, motors, switch boards, pipes, conduits, main, line and countershafts and machines may be determined, and hangers,

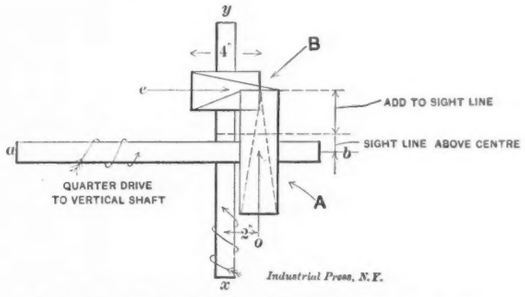


Fig. 9. Aligning Horizontal and Vertical Quarter-turn Drive.

pedestals, brackets, etc. may be placed before the shafting arrives or is finished, and the man in charge can know positively, if reasonable care be exercised, that all will be where wanted, parallel and level. Right angles and odd angles can be laid out with equal facility, and the trouble sometimes encountered by roofs being out of level, can be avoided by sighting a level line and ordering bolts and blocking accordingly. In the same way steam and exhaust pipes can be given the proper pitch for drainage without guessing and making the hangers too long or too short.

He who runs may read and profit thereby. A man may not hold a diploma to squint through a brass tube at any old thing for a target.

* * *

A Boston company, promoting a new form of rotary steam engine, designate it as "fool-proof," a legend to that effect being cast upon the casing. To make any machine foolproof is a big contract—in fact, it is one that is practically impossible. To assert the contrary in cold cast iron type is like tempting fate and is besides something of an insult to the intelligence of the operator whose share of average human nature would indeed be small if he did not some time abuse a machine so labeled.

THE GRINDING OF THREAD GAGES.*

J. R. GORDON.

I believe the best way I can answer the questions of your correspondent regarding the grinding of thread gages, is to describe the different operations I have used in making these tools. I suppose that a large proportion of the toolmakers in this country have at some time or other had the job of making gages to be used as standards of work, and that, too, without any great amount of previous experience in that line of work, and this has been my case. My first job of thread grinding occurred about eighteen years ago when I had occasion to make a tap, which, as near as I can remember, was about 1 inch in diameter, and 20 threads to the inch.

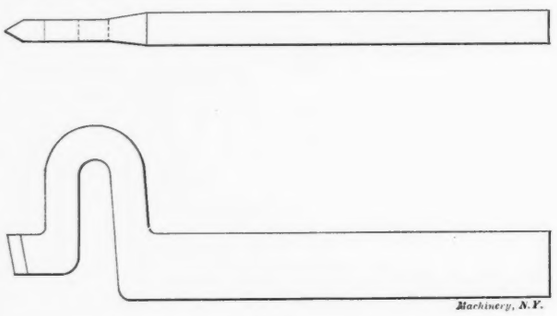


Fig. 1.

It was very important that this tap should be right, particularly regarding the pitch of thread, as it was for sizing a nut in which a measuring screw was to work. I do not remember the steel that was used in this case, but do remember that it was annealed, and was very soft and "draggy," and in order to cut the thread smoothly, it had to be taken out before the full depth of the thread was cut, and given a cold water annealing. After this was done, the thread was finished and the tap milled. It was then heated in a piece of iron pipe in the blacksmith's forge, and then dipped point first into cold water, and immediately after drawn to a light straw color. Upon examination it was found that the tap had shrunk in diameter on the end several thousandths, and the pitch had changed so that it no longer agreed with the pitch of the lathe screw.

It was decided to try grinding it, and the following method was tried. The lathe had a grinding attachment to go in the toolpost, driven by a drum on the countershaft, and in place

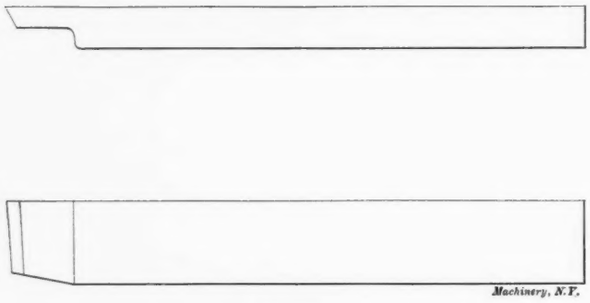


Fig. 2.

of an emery wheel we put on the spindle of the attachment a lap made of unannealed tool steel and charged with diamond dust.

Now diamond dust is by no means a common or cheap article, but it so happened that we had some left over from a job of grinding out spring chucks with very small holes, used in the same lathe in which the thread was cut, and as this was before the days of carborundum we used it for the job. The lap was charged by aid of a hardened steel bushing, acting as a roller, and it being harder than the lap the particles of the diamond were forced into the lap. When all was ready the grinding was done as follows:

The lap was carefully set to engage in the thread of the tap, so as to have as little stock to remove as possible, and the drum started; the speed was such as to give about 6,400 revolutions per minute to the lap, which was about 1½ inches diameter. The lathe was geared as for screw cutting, the pitch, of course, being the same as the pitch of the tap. The head of the lathe was turned slowly and steadily by hand until the whole length of the thread had been traversed, when the lap was backed out, and the process repeated several times. The job came out first-rate, and the tap made a beautiful thread.

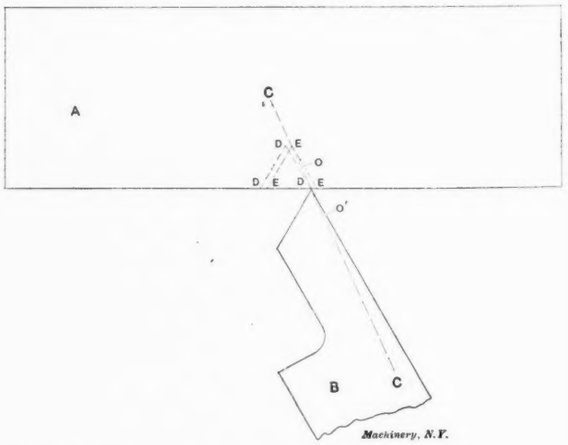
I have on one or two occasions since then used diamond dust, which may be obtained from diamond cutters generally, several of whom have shops in New York City, but I have never had occasion to grind the thread of gages, unless lapping can be called grinding. However, if your correspondent will proceed as follows he will, I think, obtain the results he is looking for. Select for the plug gage, octagon tool steel, Jessop's annealed preferred. If the diameter of the gage will permit it, drill and tap a hole for the handle, and turn and thread the gage on a nut arbor. This will not only save steel, but make it easier to harden the gage. If the lathe is not furnished with a compound rest then the threading tool should be made "goose-neck" style, as per sketch (Fig. 1). The cutting edges of the tool can not be too smooth for this work since the finer the edge the smoother the cut. The goose-neck tool will not remove stock very rapidly, so a more rigid tool should be used for roughing off the greater part of the thread.

When the lathe is furnished with a compound rest I use the following method for cutting the thread, and prefer it to any I have seen: Swivel the compound rest until the slide stands at an angle of 28 degrees from the perpendicular to the axis of the centers of the lathe. Set the tool so that its cutting sides are at the proper angle and its point the right height. Feed the tool in with the screw in the compound rest. The tool then will cut mostly on one face, the other face merely scraping off the metal on one side of the thread. The sketch (Fig. 2) shows the shape of the tool I prefer for this work. To get the proper results the thread must, when finished, be smooth, and this result will oftener be attained with steel that cuts a little brittle than with steel so soft as to drag off under the cut. The thread should next be polished, which may be done in the following manner: In place of

* This article was written at our request, in reply to a question from a contributor.

The accompanying diagram will probably make clear the reasons for swiveling the compound rest to 28 degrees instead of 30 degrees when cutting V threads. *A* is the piece to be threaded, *B* is the tool, *C C* is the line in which the tool is fed into the work. In the diagram the angle of this line is 25 degrees as the divergence of a line drawn at 28 degrees would be almost imperceptible in so small a drawing. *D D D* is the thread that would be cut if the compound rest was set at an angle of 30 degrees, and *E E E* is the thread that will result from feeding the tool in at 25 degrees.

It is apparent that the side of the thread marked *O* would show a series of steps, coarse or fine according to the depth of the cuts, when the tool is fed in at 30 degrees angle, whereas by feeding in at 28 degrees the side of the tool *O O* will scrape away a little metal each cut. It is of course understood that the point of the tool is set to 30 degrees to give the proper angles to the thread. Setting the compound rest at a less angle than 28 degrees will give more work for the side of the tool *O'* to perform, and consequently more work for the point of the tool, which is to be avoided as much as possible. The



result as to the shape of the thread would be the same in any case when the compound rest is set at any angle less than 30 degrees. If set at an angle greater than 30 degrees the shape of the thread would not be right.

the tool in the tool post put in a piece of cast-iron about the size and shape of a lathe tool and using a boring bar in the lathe, bore on the end of the piece, the arc of a circle, equal to the diameter of the gage at the bottom of the thread. Next thread this cast-iron piece the same as a chaser on the end by putting a threading tool in the bar in place of the boring tool, and, keeping the setting as it is, put the gage between the centers and using the cast-iron piece as a lap, polish the thread by chasing it over with the screw-feed. The lap should be very lightly charged with emery or carborundum and moistened with benzine to distribute the abrasive evenly.

To harden the gage procure an iron pot, such as is used to melt solder in and of sufficient size to leave room all around the largest gage to be hardened. This pot should be filled with cyanide of potassium, which should be heated until the proper color is attained. Wire the gage with wrought iron-wire, using care not to injure the thread and leaving ends to which the tongs may be applied. Place the gage in the pot and leave it there until the proper degree of heat is attained. This will be found to be somewhat deceptive at first, and the color will be lower than it appears in the pot, to those who have never used this method before. When properly heated remove and plunge in cold water; if the gage is of one piece put the handle end first, dipping it in moderately fast, and when cold draw immediately. If the gage is made with the handle separate it should be plunged into the water edge-wise. The gage will be found to be bright and clean and to have a very hard shell.

Now return it to the lathe, and using the same lap polish the thread again. Unless the gage has sprung to an unusual degree the lap will quickly polish all parts of the thread. The object of heating in the cyanide is to give a perfectly even heat to prevent springing, and the reason for using octagon steel is the same, it being more evenly rolled in the mill.

When putting the gage in cold water from the pot of cyanide the workman should use care to protect his face and person from the hot cyanide, which flies when it comes in contact with cold water.

For the ring gage the lap should be made of cast-iron, turned the right diameter and threaded, after which it is sawed through the middle, leaving both ends solid. Provision for expanding the lap may be made by a screw whose head comes below the bottom of the thread; or, if the gage is small, by drilling a hole in the end deep enough to reach about half the length of the lap and driving a wedge in to expand it. I have seen threads of ring gages that were made by a hob tap and they were very nicely made, but if the tap "goes" in hardening it is as much work to correct the tap as it is to make the gage originally, so I prefer cutting the thread in the lathe, especially if the gage is split.

Some may prefer to use animal charcoal for heating the work in; in any case, the work should be kept from the flame and air as much as possible.

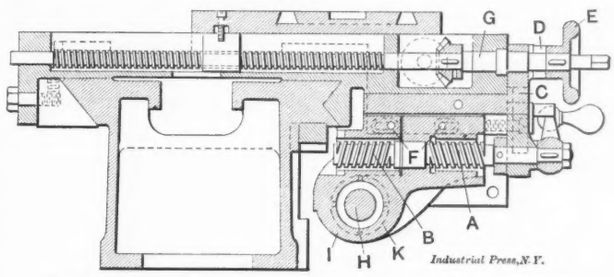
* * *

GERMAN LATHE CARRIAGE FOR SCREW CUTTING.

ROBERT GRIMSHAW.

The mechanical arrangement here shown is intended to simplify the transmission in thread cutting, the opening of the two parts of the nut being employed to withdraw the lathe tool so that only one motion of the hand is necessary. Above the two parts of the split nut, *I K*, which lie under the carriage ways and are opened and closed by a screw with a double right and left hand thread, *A* and *B*, there is an L-shaped slide having the same direction of motion, and this surrounds a shoulder on the upper part of the split nut and slides on the latter. In the front part of this slide, which is directed upward, the carriage spindle has a swivel bearing and is secured by the nut, *D*, and the check nut, *E*. While the spindle *G* follows all of the movements of the slide its own movement is unrestrained. Through the shoulders of the nut are bored the holes, *FF*, in which a steel bolt is accurately fitted. There are in the carriage, slots for this bolt which plays freely therein. Accordingly as the thread to be cut is external or internal, the bolt is placed in the front or the rear half of the nut and this is connected to the slide so that the latter, and with it the upper carriage, must follow, with the cutting tool, the movement of the nut.

In thread cutting the operation is as follows: As soon as the tool is at the end of the thread, the nut opens and the tool is withdrawn from the cut. The carriage is then, by means of the rack, brought back again by hand, the carriage spindle, *G*, is turned far enough for the next cut and the nut is closed. This brings the tool to exactly the depth for the second cut. The lathe runs continually in the forward direction and the tool is almost always in the cut, as the running back of the carriage takes but little time.



Section of German Screw-cutting Lathe Carriage having Automatic Retracting Device for Tool.

This arrangement enables cutting all threads with pitch of an even number. For odd pitches it is necessary to take care that at the commencement of each new cut the lead-screw, *H*, and the driving arbor have the same relative position, and the carriage be brought to the same place, as before. This is easily managed by starting out, before commencing the thread, with the carriage against the tailstock; or if the threaded portion of the work-piece does not reach far enough, against an interposed piece of metal. The faceplate or the chuck is then turned by hand until the leadscrew nut, *I K*, can be shut without meeting with any resistance or requiring the carriage to be moved lengthwise of the lathe. This position of main arbor and leadscrew is indicated by a chalk mark on the faceplate (or the chuck, as the case may be) and the leadscrew. At each new cut the carriage is brought back to the tailstock or to the distance-piece mentioned, and the nut will close as soon as the two chalk marks appear in the positions in which they were originally made.

This arrangement of the nut saves much time over the usual way of running back the carriage by the belt, and running the tool in and out of the cut; further, the proper strike and depth of the tool are assured. Where the lathe is used for ordinary turning, the connection of the slide with the nut checks is broken by withdrawing the bolt, and the slide is connected with the carriage by putting the bolt in a hole which is bored through carriage and slide, over the slots. The carriage spindle is then connected with the carriage and the nut can be opened and closed independently of the slide, as is the case on ordinary lathes. Lathes fitted with this arrangement are built by H. Wohlenberg, Hanover, Germany.

* * *

Sir William Ramsey, the noted British chemist who recently visited the United States, spoke fully as enthusiastically of radium as a number of other noted physicists who have been quoted. Among other interesting statements, he said that the amount of pure radium existing in the radium compounds isolated by M. Curie and others, is very small indeed—a mere fraction of an ounce, in fact. He stated that radium-bromide dissolved in water, separates it into its component gases, hydrogen and oxygen, and continues to do so indefinitely in spite of all natural laws with which physicists have heretofore been acquainted. This, however, is not the only instance, by any means, in which radium seems to confound the doctrine of conservation of energy. But in this connection it is somewhat puzzling to understand the statement of Sir William that one pound of radium would evolve as much energy as the explosion of 250 tons of dynamite. While this expression is certainly impressive, it falls far short of continuous evolution of energy.

TOOL MAKING.—11.

DRILLS.

E. R. MARKHAM.

Drills used in machine shop work are of several varieties. The more common forms are the flat drill, single-lip drill, straightway drill and twist drill.

Flat Drills.—Flat drills are made with shanks of suitable form to allow them to be held in chucks or collets, as shown in Fig. 1. If intended for use in the engine lathe, for chucking, they are made as in Fig. 2. One end is centered as shown, and this rests on the tail center of the lathe. As this form of drill is seldom used to produce a hole of exact size it is customary to forge it to size and shape, finishing by grinding. If it is necessary to have the drill cut approximately exact to size, it may be forged somewhat wider than desired finish size. Both ends must be centered and the drill turned to size in the engine lathe. If the drill is to be ground to size after hardening, the projection *A*, Fig. 3, must be left on until after grinding. It is seldom considered advisable, however, to drill holes that must be exact with this form of drill, so the operation of grinding is not resorted to in many cases.

As the turning of a piece of stock of this form would have a tendency to cut the portion of the edge nearest the flat surface a trifle deeper than the balance of the edge, it might bind when cutting unless given sufficient relief. This is ordinarily accomplished by draw-filing. When the drill is ground to size the operation of draw-filing is not resorted to. The amount of relief given the edges should be small; .003 or .004 inch will be found sufficient. If given too much the tool will chatter when cutting. The shank should be a trifle smaller than the body of the drill, to prevent its touching the walls of a hole drilled deep enough for it to enter.

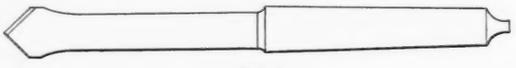


FIG. 1

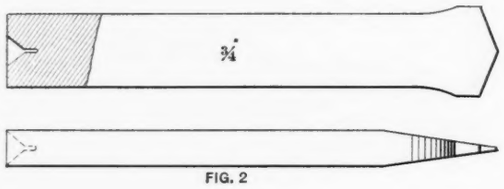


FIG. 2

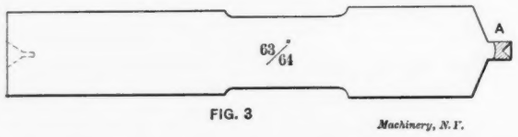


FIG. 3

Machinery, N.Y.

When a drill of this form is forged care should be exercised in heating and hammering. It should not be overheated, for this causes brittleness. The blows should be rapid and no heavier than should be given a piece of steel of the size in hand; and as the steel gets cooler the blows should be lighter to prevent a tendency to fracture the grain of the steel.

When hardening, the steel should be given as low a heat as is consistent with the steel used. The heat should extend a trifle further up than we wish the drill hardened. When dipping in the bath it should be worked up and down, to prevent a water line, and around to prevent the steam forming a cushion around the steel, which keeps the water away from the steel and prevents the operation of hardening. The water line referred to is caused by dipping a piece of red hot steel in the bath and holding it in a fixed position. This causes it to contract up to a certain point, which corresponds to the surface of the bath, and as the portion above the surface will, of course, not contract as rapidly as that below, there will result an uneven contraction each side of this given point, and the steel will either crack or break off at the surface of the bath. Working the red hot steel up and down distributes the point of unequal contraction over a greater surface and does away with the tendency to crack. These remarks apply equally well to any piece of steel which is heated for a distance greater than we wish to harden.

For use in drill press work flat drills have been almost entirely superseded by twist drills, yet at times the former are very useful. This is especially the case when an odd-sized drill is wanted, or when it is necessary to drill through the hard scale on the surface of cast iron. When drilling holes in tempered steel flat drills work much better than any other form, partly on account of their shape, and because they can be left very much harder than if a corresponding size of twist drill were used. Flat drills for drilling tempered steel will be found much harder and tougher if dipped in a bath of

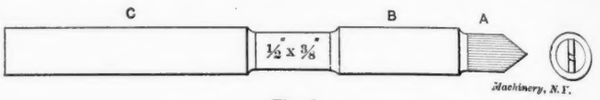


Fig. 4.

mercury instead of water, or in the absence of mercury a block of lead may be used. Before hardening, the drill may be driven into the lead for a short distance, care being taken not to crook it by carelessness when driving. It may then be removed from the lead, heated red hot, and placed in the hole in the lead. Lead absorbs the heat in the drill rapidly enough to insure extreme hardness, and yet the action is such that extreme brittleness does not follow.

I have seen small drills, gravers, and similar tools hardened very nicely by carefully heating to a red heat and then sticking them into a potato. When drilling tempered steel use turpentine instead of oil as a lubricant.

Transfer drills are used when it is desired to transfer a smaller hole from a larger without changing the location. The portion *B*, Fig. 4, is of the size of the larger hole, while *A* is of the size of the hole to be transferred, and is a short, flat drill. The shank may be of any convenient size. After turning the various portions to size the cutting portion *A* is milled or filed to thickness. The cutting lips are then backed off and the drill hardened. The portion *B*, which runs in the hole already made, should be hard to prevent its roughing from frictional contact with the walls of the hole. The cutting portion is drawn to a straw color, while the portion *B* is left as hard as when taken from the hardening bath.

Single Lip Drill.—For certain classes of work this style of drill is very useful. As it has but one cutting edge its action

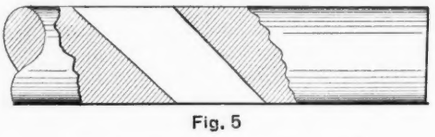


Fig. 5

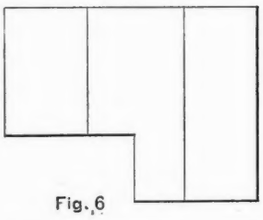
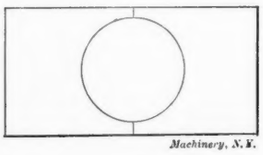


Fig. 6



Machinery, N.Y.

is similar to that of a boring tool used in an engine lathe for inside turning. The body of the drill being the size of the hole to be drilled there is little danger of its running, even when drilling stock containing blow-holes or where it is partly cut away. It does not cut as rapidly as other styles, and consequently is not used where a twist drill will answer; but for certain work it answers much better. When it is necessary to drill holes at an angle, through a cylindrical piece of stock, as shown in Fig. 5, this drill works better than the others, provided it is guided by a rest or bushing. It also

works nicely when drilling holes through a piece like that shown in Fig. 6, where part of the stock is cut away. In this case the drill could be guided by a bushing or the hole could be started with a twist drill and finished with the single lip.

In Fig. 7 is shown a form of single lip drill to be used with a bushing. The blank should be roughed to a size somewhat larger than finish size. The portion *C* should be turned to size and the size of the drill stamped on it, after which the shank, *B*, and the cutting end, *A*, should be finished to size, and finally the portion marked *A* may be milled as shown, so that just one-half of it remains.

If the drill must cut a hole true to size it will be necessary to make it a few thousandths of an inch large and grind it to size after it is hardened. To grind the drill it will be found necessary to face the end back, leaving the projection, *A*, containing the center, as shown in Fig. 8. After grinding, the projection may be ground away and the end of drill ground for clearance, so that it may cut. The shape to give the end is shown in Fig. 9. If single-lip drills are to be used on iron and steel and *not* on brass, they will cut more freely by making them as shown in Fig. 10. This cutting rake is given by mill-

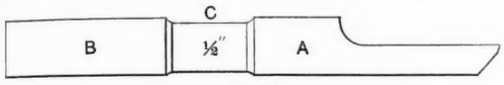


Fig. 7

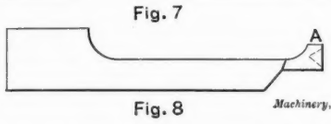
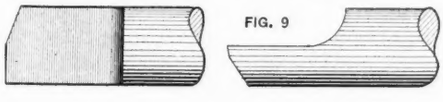


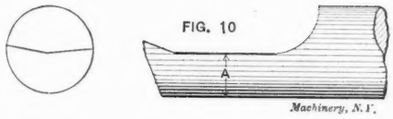
Fig. 8

Machinery, N.Y.

ing the portion *A* to the desired size, which is one-half the diameter of the blank. The end and sides of the blank are heated to a blue, or covered with the blue vitriol solution and the desired shape laid out with a scratch awl. It is then placed in the milling machine chuck on the index head, or in the vise, at the desired angle and the desired amount of rake given by milling with small end mills. The cutting lip must of course run to the center. If it is not cut as deep as the center it cannot cut; if cut deeper than one-half way it will cut, but leave a projection standing in the center of the hole. Use extreme care in heating these drills for hardening, and dip in warm water or brine to prevent springing. Many old hardeners treat drills of this form, and similar pieces of work, by dipping in the bath at an angle, as shown in Fig. 11, so as to counteract the tendency to spring from unequal contraction occasioned by unequal amount of stock at the various portions of the drill.

When single lip drills are used constantly they are made with detachable cutting blades, as shown in Fig. 12. In this case compensation can be made for wear by blocking up under the blade by means of thin sheet metal or paper. It is necessary to have the face of the blade radial. The cutter is held in position by means of two screws, as shown.

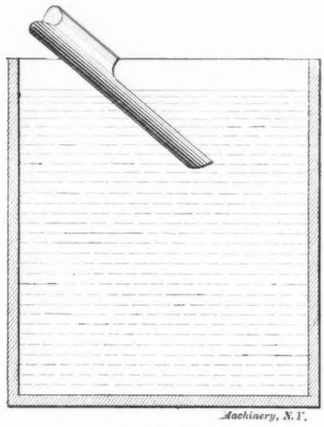




Machinery, N.Y.

Straightway or Straight Fluted Drills.—These differ from twist drills in that the flutes are parallel to a plane passing through the axis of the drill, as shown in Fig. 13. They are used in drilling brass and the softer metals as the tendency to draw in, peculiar to twist drills, is eliminated by the form of the flute. They are also used in drilling steel and iron when the holes break into each other, as in Fig. 16, and consequently are used when drilling for the impression in punch press blanking dies and similar work. Drills of this style, and sold in the market, have their flutes milled with a special milling cutter, although a very satisfactory drill may be produced if the flutes are made by use of an ordinary side milling cutter like that shown in Fig. 20, leaving its corner somewhat rounded to produce a round corner; this gives additional strength and reduces the tendency to crack when the drill is hardened.

Twist Drills.—In general it is not good policy to make twist drills in the ordinary machine shop; a superior article can be purchased at a cost much below that at which they are produced by machinery not especially designed for this purpose.



Machinery, N.Y.

Fig. 11.

However, at times it is desirable to make a drill for a special purpose, even though the cost is greater. In an emergency the factor of cost cannot always be taken into consideration, and especially when the cost is not great enough to be considered prohibitive. When drawn wire (drill rod) of the proper size and quality can be procured, this can be used; for sizes where it is necessary to turn the stock to size it is well for the operator to use stock enough larger than finish size to enable him to remove the decarbonized portion at the surface.

For most purposes drills which are smaller than ½ inch diameter need not be ground to size after hardening; but if true holes of the size of the drill are desired it is necessary to grind them of a size larger than that above mentioned. To retain the center for use in grinding, the projection on the cutting end, Fig. 14, should be left until after the operation of grinding. After the flutes have been cut and the drill ground to desired size, the projection may be ground off and the cutting lips ground to the proper shape, as shown in Fig. 15. The smaller drills, which are made from drill rod, are cut to length, and the cutting end is given the desired angle,

Diameter of Drill.	Thickness of Cutter.	Pitch in Inches.	Gear on Worm.	First Gear on Stud.	Second Gear on Stud.	Gear on Screw.	Angle of Spiral.
1/16	.06	.67	24	86	24	100	16° 20′
1/8	.08	1.12	24	86	40	100	19° 20′
3/16	.11	1.67	24	64	32	72	19° 25′
1/4	.15	1.94	32	64	28	72	21°
5/16	.19	2.92	24	64	56	72	20°
3/8	.23	3.24	40	48	28	72	21°
7/16	.27	3.89	56	48	24	72	20° 10′
1/2	.31	4.17	40	72	48	64	20° 30′
9/16	.35	4.86	40	64	56	72	20°
5/8	.39	5.33	48	40	32	72	20° 12′
11/16	.44	6.12	56	40	28	64	19° 30′
3/4	.50	6.48	56	48	40	72	20°
13/16	.56	7.29	56	48	40	64	19° 20′
7/8	.62	7.62	64	48	32	56	19° 50′
15/16	.70	8.33	48	32	40	72	19° 30′
1	.77	8.25	86	48	28	56	19° 20′

which is 59 degrees to one side of the blank. When milling the flutes use cutters which will produce grooves of the proper form. These cutters are manufactured by the Brown & Sharpe Mfg. Co., Providence, R. I. The above table and the following explanation are taken from Brown & Sharpe's book, entitled "Construction and Use of Milling Machines," being intended for use with their twist drill fluting cutters. These cutters are made both right- and left-handed, and it is somewhat better to use left-handed cutters, especially for small drills, as the cut commences at the shank, thus preventing the blank lifting from the action of the cutter.

The cutter is placed on the milling machine arbor, directly over the center of the drill, and the bed of the milling machine is set at the angle of spiral as given in the table.

To obtain increased strength the depth of groove of a twist drill diminishes as it approaches the shank; otherwise the drill would break from the strain incident to cutting. The variation in depth depends on the desired strength or the use of the drill. To obtain the necessary variation of depth, the spindle of the spiral head is elevated somewhat, depending on

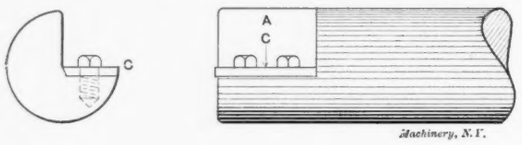
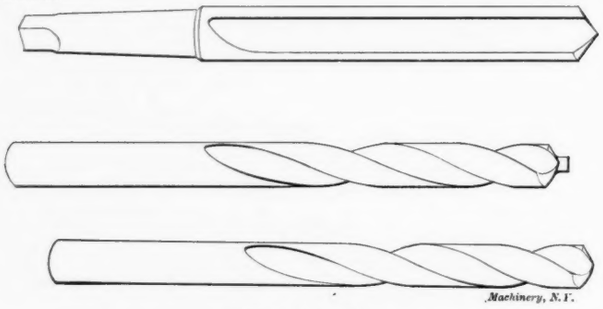


Fig. 12.

the length of the flute to be made. When less than 2 inches in length the angle should be ½ degree; for 5 inches and over in length, 1 degree. Usually this will be found satisfactory, but for extremely long drills the elevation must exceed these amounts. The outer end of the drill must be supported, as shown in Fig. 17, and when small should be held down firmly until the cutter has passed over the end. If left-handed cutters are used the pressure of the cutter holds the blank down so it is not necessary to use other means. When large drills are held by the centers the spiral head should be depressed in order to decrease the depth of groove as it approaches the shank.



Figs. 13, 14 and 15.

Another very important operation on the twist drill is that of "backing off" the rear of the lip, to give it the necessary clearance. In Fig. 18 the bed is turned to about ½ degree, as for cutting a right-hand spiral; but as the angle depends on several conditions it will be necessary to determine what the effect will be under different circumstances. A study of Fig. 18 will be sufficient for this, by assuming the effect of different angles, mills, and the pitches of spirals. The object of placing the bed at an angle is to cause the mill *E* to cut into the lip at *C* and have it just touch it at *S*. The line *R* being parallel with the face of the mill, the angular deviation of the bed is clearly shown at *A* in comparison with the side of the drill.

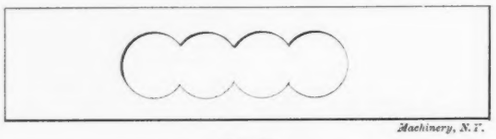


Fig. 16.

While the drill has a positive traversing and relative movement, the edge of the mill at *C* must always touch the lip a given distance from the front edge, this being the vanishing point. The other surface forming the real diameter of the drill is beyond the reach of the cutter, and is left to guide and steady it while in use. The point *C*, Fig. 18, shows where the cutting commences and its increase until it reaches a maximum depth at *C*, where it may be increased or diminished according to the angle employed in the operation. The line of cutter action is represented by *I I*.

Before "backing off," the surface of the smaller drills in particular should be oxidized by heating until it assumes some distinct color to clearly show the action of the mill on the lip of the drill, for, when satisfactory, a uniform streak of oxidized surface, from the front edge of the lip back, is left untouched by the mill, as represented at *E*.

If drills are to be ground and it is not considered advisable to center them, pointed projections of an angle of 60 degrees may be left at either end, as shown also in Fig. 18. The projections may be run in female centers in the grinding machine. After the drill has been ground to the desired size the projection on cutting end may be removed by grinding. If large holes are to be drilled deep the drills must be ground slightly tapering, making them smaller toward the shank. The amount of taper should be about .003 inch in 6 inches of length. This slight taper prevents their binding in a drilled hole, and yet is not great enough to allow the drill to run appreciably.

When hardening any tool it is, of course, necessary to conform to the facilities offered in the individual shop for doing such work; but in order to successfully harden twist drills suitable means must be provided, especially if the drills are comparatively large.

In shops where twist drills are manufactured for the market special methods of heating are provided, which insure uniform heats, and the maximum amount of work turned out. These methods are not generally understood outside the shop where they are in use, and would be of little value if they were, as it would not be feasible to install such equipment for a limited amount of work.

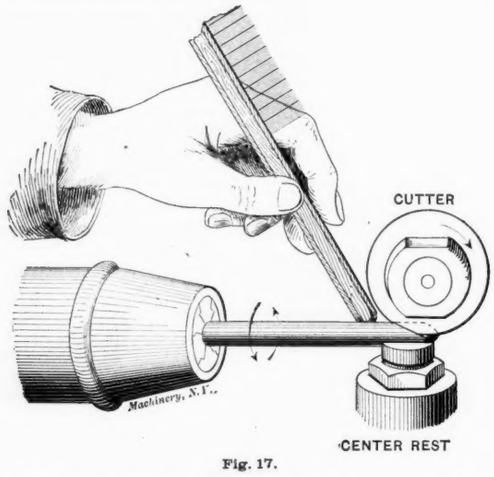


Fig. 17.

The drill must be uniformly heated and to the lowest temperature consistent with results desired. The various portions of the twist drill are of such unequal thickness that it is necessary to heat slowly or the lighter portions would be overheated before the heavier parts were sufficiently hot. Twist drills are subjected to great strains and should be as strong as possible; for this reason the heats should be the lowest possible. The shape of the lands of the drill is such that the steam formed by the contact of water with the red hot steel prevents the water from getting into the flutes and properly hardening the portion at the bottom, and as this portion forms the point of the drill, as it is ground back, it is necessary that it be hard. To overcome the tendency of the steam to force the water from the grooves a bath should be used which will insure the water reaching the bottom of the flutes. Such a bath is shown in Fig. 19. It has a jet of water coming up from the bottom, and also has perforated pipes coming up on the sides by means of which water is projected against all sides of the drill and to the bottoms of the grooves, thus insuring their hardening. This form of bath has been shown in a previous article of this series, but it is of such "all round" value, and especially when hardening articles of peculiar and irregular form, that it seems wise to again call attention to it.

The drill should be heated in a tube to prevent the fire coming in contact with the steel, unless we are using a muffle furnace, or some form where the steel is not exposed to the action of the fire or the air. A crucible of red hot lead furnishes a satisfactory means of heating drills, provided the precaution is used to prevent the lead sticking to the drill.

The following solution not only prevents the lead sticking, but as it is of a carbonaceous nature it increases, in a measure, the surface hardness:

Pulverized charred leather	1	pound
Fine family flour	1½	pounds
Fine table salt	2	pounds

The charred leather should be pulverized very fine; in fact it should be sifted through a No. 45 sieve. The three ingredients

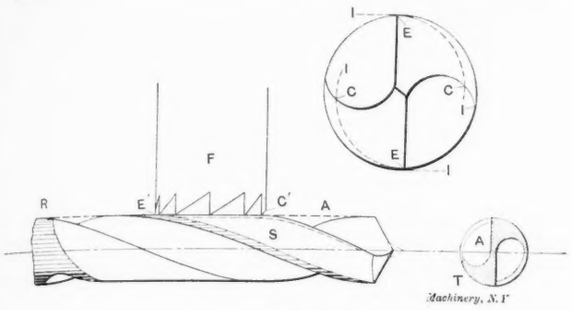


Fig. 18.

should be thoroughly mixed while in the dry state, then water should be added slowly to prevent lumps, enough water being used to bring the mixture to the consistency of varnish.

The drill may be dipped in the mixture and set in a warm place to dry, as it is never safe to immerse anything that is damp in red hot lead, the presence of moisture causing the lead to fly, endangering the eyes of the operator.

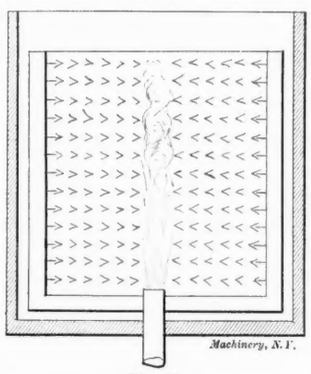


Fig. 19.

When the drill is uniformly heated it is immersed in the hardening bath and after hardening, the temper may be drawn. The amount necessary to draw the temper depends on the heat given the steel when it was hardened and the use to which the drill is to be put, although for most work a full straw color (460 degrees) is about right.

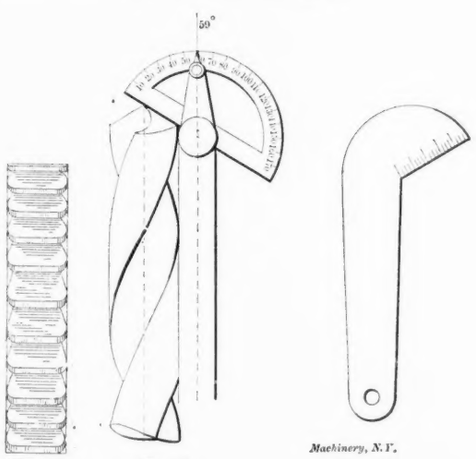


Fig. 20. Fig. 21. Fig. 22.

Grinding Twist Drills.—The use of grinding machines designed especially for properly grinding the cutting lips of twist drills, has in a great measure done away with the extreme care necessary when grinding tools of this character by hand. Yet many shops are not provided with such machines and, as it is necessary that twist drills be properly ground, it is advisable for the young mechanic to learn to rightly grind them by hand.

Drills which are properly made have their cutting edges straight when the lips are ground to the proper angle, which, as previously stated, is 59 degrees, see Fig. 21. Grinding to an angle less than 59 degrees leaves the lip hooking, which is likely to produce an undesirable hole. An experienced operator can grind the lips of a drill to the desired angle and length, gaging the shape by the eye. The inexperienced, however, will find a gage of the form shown in Figs. 21 or 22 a great help, as by its use the correct angle and length of lip can readily be determined.

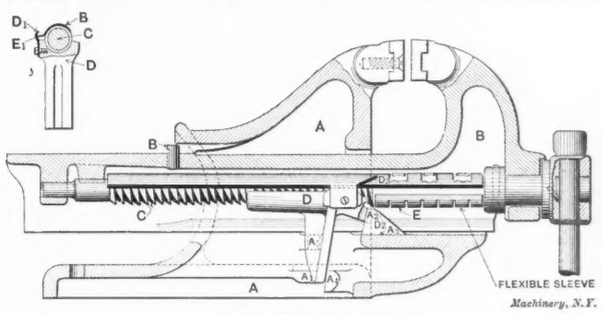
* * *

QUICK-ACTION BENCH VISE.

A large number of quick-action bench vises for machinists' use have been placed on the market, some of which have had very ingenious features. Among this number must be included a new design brought out by Charles Taylor, of Birmingham, England. For the illustration and condensed description, we are indebted to the *Mechanical World.*

A is the fixed jaw and body combined in one casting; *B* the usual sliding jaw; *C* the screw; *D* the half-nut customarily employed in this type of vise; *E* a sleeve which actuates the half-nut, replacing the usual mechanism actuated by means of a trigger, springs, etc. The half-nut *D* is engaged with or disengaged from the screw *C* automatically while rotating the screw in the act of gripping or releasing work, the movement comprising about 1-12 of a turn. Hence the whole work of gripping, releasing, engaging, and disengaging the mechanism is done by one hand in a normal movement of the lever.

In the illustration the half-nut is shown in engagement with the screw. It will be seen that immediately the gripping pressure is relaxed by turning the screw in an anti-clockwise direction, the nut, being free to do so, will fall out of engagement, leaving the jaw *B* free to slide. The work being placed between the jaws, the jaw is pushed up to the work. The lever is then rotated exactly as though the vise was a continuous screw vise. The first portion of the turn (one-twelfth of a turn) raises the nut into full mesh with



Quick-acting Bench Vise.

the screw, by means of the sleeve *E*, which has a flexible grip upon the screw and turns with it until held by some positive stop (but not shown), the projection or lip E_1 (see end view) engaging the corresponding lip D_1 of the nut. While lifting, the screw and nut may make contact at the tips of the threads, and the nut be prevented from rising further by reason of the binding strain arising from the forward motion of the screw's thread, and then the tips of the thread are apt to break off. This is a point of failing in similar vises, but it is completely obviated in this vise, thus: A slight clearance is permitted in the upper way A_1 to allow the nut to fall away from the abutment A_2 by reason of its unbalanced position, and by the legs D_2 resting upon the part A_3 of the body. The angular disposition of the ways also tends to the same end, the nut advancing while rising, so minimizing the effect of the advancement of the thread while the screw is turning. This feature with a thread slightly undercut on its acting face also tends to cause a clinging together of the screw and nut, making it impossible for them to separate under blows or vibration. In the ordinary style of screw, the lever hole usually becomes bell-mouthed and reduced in diameter by an accumulation of oily grit, so tending to bind the lever. To mechanics this forms a well-known finger trap. By the removal (by drilling) of the metal at the center of the hole this sticking nuisance is obviated.

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MACHINERY

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1904.

NET CIRCULATION FOR SEPT., 1904,—24,156 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 480 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad. RAILWAY MACHINERY, $2 00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

A movement has been started in New Haven, Conn., to erect a monument to Eli Whitney, the inventor of the cotton gin. A committee has been formed to raise a fund, and when Congress meets, a petition will be presented asking the government to make a substantial appropriation as a basis for the fund. It is proposed to erect the monument in Whitneyville, where Whitney first made his cotton gin and later established his famous factory for the manufacture of firearms.

* * *

Modern machinery applied to many industries has a tendency to shatter poetical ideals. A favorite theme has been the danger, toil and privation of the fisherman's life, and the somber pictures have by no means been overdrawn, but according to a recent report from the U. S. consul at Gothenburg, Sweden, the modern fisherman is likely to escape a great deal of the toil and danger that appeared inseparable from his lot. He says that a good many of the fishermen buy petroleum motors for their boats or cutters, some from Denmark and some from the mechanical works at Lysekil. The motors are expensive, but save so much work and delay at sea that they are still considered advantageous. The first motors used by the fishermen here were made in the United States. Boat motors are now made at several places in Sweden, however, and Denmark seems also to have gained a market there. The Northern Fisheries Exposition held in July, in the city of Marstrand, was expected to make the fishermen more familiar with the advantages of boat motors and to increase the demands for them.

* * *

FIRST AMERICAN ALTERNATING CURRENT RAILWAY.

What is expected to work a great improvement in electric railway operation and to further the transformation of steam roads to electric systems, is a new motor developed by the General Electric Company which works equally as well with either direct or alternating current. Electric railways in general are now operated with direct-current motors with voltages of 550 to 600 volts. For heavy service and extended systems the cost of copper required at this voltage becomes a serious item, and for some time there has been felt the need of a higher trolley voltage. The possible use of alternating current for the trolley would admit of a higher voltage than is possible with direct current, as the voltage could be reduced by a transformer on the car to the potential required by the motors. The development of the large power stations and transmission systems, has been principally with alternating current, requiring rotary converters or other transforming devices for changing the alternating current into direct current suitable for the operation of electric railways. Obviously there would be a great advantage in a railway-motor equipment that could be operated from an alternating-current high-voltage trolley and without the necessity of intermediate-commutating devices. Such an alternating-current equipment would offer a further advantage if it could be operated both on alternating extensions of existing systems and on the direct-current trolley where the latter is already installed.

The development of the single-phase commutator motor and its inherent fitness for traction work have created wide attention among railway interests, and work of a practical nature has been actively pushed on both sides of the Atlantic. Considerable interest therefore attaches to the operation in regular service by the Schenectady Railway Company of single-phase alternating-current motors on its Ballston extension. This is the first instance in this country, it is believed, of an alternating-current road in regular service carrying passengers, and its commercial possibilities are largely due to the fact that the motors operate with alternating-current power outside city limits and with direct-current power within the city limits. The motor as installed on the Ballston line is of the "compensated" type, so named on account of the character of the field winding, which fully neutralizes or compensates for the armature reaction. Both the compensated motors and control are adapted for operation on the 2,000-volt alternating-current trolley between cities and the standard 600-volt direct-current trolley in Schenectady. This ability of the compensated-motor equipments to run over tracks equipped with either alternating-current or direct-current trolley makes their field of application very broad, as the cars can secure all the benefit of running over existing city tracks without in any way sacrificing their running qualities upon suburban sections equipped with alternating-current trolley.

The alternating-current motor with its inherent advantages of high-voltage distribution is particularly adapted to replace the steam locomotive on either high-speed passenger or heavy-freight haulage work; and as the compensated type of motor is perfectly adapted to operate on both alternating-current and direct-current trolley, the alternating-current motor must be considered a large factor in future suburban-railway systems. The compensated motor is essentially a variable-speed motor, differing in this respect from the multiphase-induction motor, whose constant-speed characteristics proved so serious a handicap to its successful adoption in railway work. The speed-torque characteristic of the compensated motor is very similar to that of the direct-current series motor, while its commutating qualities and method of control prove equally satisfactory.

* * *

Successful photography of machine shop interiors is greatly hampered by "halation" around the window, skylight and monitor openings. That is, every opening toward the light is surrounded by a halo in the developed plate which destroys all detail for some distance from the edges. This effect is partially due to the reflection from the interior back surface of the glass plate, thus causing the fog. The so-called non-halation plates are more or less effective in cutting down the destructive effects of halation, but perhaps the best results are obtained by backing the plates with some dark non-reflecting substance. A backing that is recommended by one having experience consists of lampblack and gum-arabic mixed in the proportion of two spoonfuls of lampblack to one of gum-arabic with sufficient water to make a stiff dough. The mixture hardens into a cake and is applied to the back of the plate with a rag, and must be carefully wiped off before developing. Only a thin coating is required and it is easily removed. Backings containing glycerine are said to be bad on account of drawing moisture from the atmosphere.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The reliability and durability of the gasoline motor as applied to automobiles would seem to be pretty well demonstrated by the recent non-stop record of a Darracq touring car which made the trip from New York to St. Louis—3,400 miles—without stopping the motor during the entire run. Altogether the motor ran over fifteen days without stopping and during most of this time it was being jolted over roads, some of which are the worst in the country.

A great modern hotel like the Hotel Astor, recently completed in New York City, contains much that is of interest to the engineering profession. This hotel has a large power plant that is one of the show features of the place. It includes four Rice & Sargent tandem compound Corliss engines of 250 kilowatt capacity each, making the total power capacity nearly 1,400 horse power. This immense power capacity is required for the lighting system, operation of elevators, machinery connected with the operation of the kitchen, the ice and refrigerating system, etc.

An ingenious rifle sight called the "hyposcope" is being introduced to the notice of military authorities in Europe, which enables a soldier to sight and fire over a parapet, or other barrier, without exposing any portion of his body. The hyposcope consists of a light metallic tube made L-shape, which is clamped to the side of the barrel with the long part of the "L" vertical and the short part lying across the top of the barrel. A series of mirrors within the L-tube accurately reflect the image of the distant object in conjunction with the rifle sights to the eye, although the soldier's head may be 5 or 6 inches below the normal sighting position.

In his presidential address at the twelfth annual convention of the National Railroad Blacksmiths' Association, Mr. Lindsay referred to the fact that the secret of success is often hidden by a very thin vail, and in that connection mentioned that Professor Langley of the Smithsonian Institute, experimenting on alloy steels twenty years ago had the secret of high-speed steel within reach, but the world lost its use for fifteen years simply because he did not know how to harden it. It would have been deemed the height of foolishness then to have hardened the steel by "burning" it, but that was the secret discovered by Taylor and White, forming the basis of their famous process, which has revolutionized machine shop practice.

It doubtless has often been a matter of curiosity to many how large railway companies keep track of their locomotives. That they do keep track of them is pretty generally conceded, but there is apparently an exception if the statement of a British newspaper is to be relied on; it states that the London & Northwestern Railway has lost a locomotive. Engine sheds are being searched and every mile of the line is being examined from London to Cornwall, but no trace of the missing engine has been found. How it could have vanished the railway officials do not know; but they have two explanations to offer. One is that the engine may have been shunted on to some branch line in Cornwall or Devon, and its existence forgotten, and another that a new number may have been given to it, and the old number still retained on the company's book.

In a communication to the *American Engineer*, Mr. Edward L. Coster gives some figures showing the wonderful efficiency of heating surface of a De Glehn compound Atlantic type express locomotive on the Paris-Orleans Railway. One of these locomotives, which weighs only 80 tons, recently developed 1,900 horse power at a speed of 70 miles per hour. The total heating service of this locomotive is 2,616.8 square feet, hence it developed one indicated horse power for each 1.38 square feet of total heating service, or 0.73 indicated horse power per square foot of heating service. This would indicate that the locomotive boiler is an exceedingly efficient device for boiling water so far as heating area is concerned.

In referring to an accident that occurred in the Robinson Deep mine in South Africa a few months ago, a mining exchange cynically remarks that the hoisting rope broke at a point 350 feet from the top and the cage was precipitated to the bottom of the shaft, 2,050 feet deep, with the result that forty-three Kaffir "boys" were missing from the mine complement. A powerful writer of modern fiction has remarked that there is nothing so cheap as human life, and it would seem that the stony indifference of mine owners goes a long ways towards confirming the statement. Is there any good and valid reason why mining cages cannot be fitted with safety catches to hold them in case of the hoisting rope breaking?

The Technology Club of Syracuse was organized at Syracuse, N. Y., on January 6, 1904, with a membership of 129, including engineers, architects, analytical chemists, metallurgists and geologists. The headquarters of the club are at 707 Dillaye Building. Meetings are held monthly except during June, July, August and September. Annual election of officers is at the October meeting. Visits to manufacturing plants are one of the features of entertainment and instruction and on June last the club took a trip over the Auburn & Syracuse Electric Railway to Auburn, N. Y., and visited several large manufacturing plants and the power house of the above-named railway. Prof. John E. Sweet is president of the new organization.

A collector for the Central District and Printing Telephone Company, states the *Western Electrician*, in opening the money receptacle of the pay stations in four Allegheny, Pa., drug stores discovered a number of coins of the same design as the ordinary penny, but of weight and size of a dime. He reported the matter to the treasurer, who summoned the secret service operatives to his assistance. Examinations were made, and it was discovered that, instead of being counterfeits, the money was nothing more or less than copper cents which had been worked into the size of dimes. Chemical tests showed that the result was attained by immersing the coin in muriatic acid until it was reduced to the desired size, the operation taking about 40 seconds.

A newspaper item states that the *Governor Stanford*, No. 1, the first locomotive to cross the continent from the Pacific coast, is being placed in the Stanford Museum, where it will remain permanently as a relic. This engine was built in the early 60's and was brought from the East around Cape Horn in 1867. After the driving of the golden spike, the last act in the completion of the Central Pacific Railroad, on May 10, 1869, No. 1 was used by Gov. Stanford to draw his private train through Nevada to the scene of the exercises. The Central Pacific Company gave the engine a few years ago to Mrs. Stanford. It has been resting under a shed on the university campus, but is now being removed to the museum, where the rust is being scraped from it, the metal work polished and a new coat of paint added to make it appear as nearly as possible like it did when it was the finest type of locomotive in use.

The bandsaw has worked a considerable change in woodworking machinery, but so far its use in the machine shop is comparatively limited. It is, however, used to some extent with special blades for cutting off bar stock and similar work. A British concern, Clifton & Waddell, near Glasgow, has, however, applied the bandsaw to an interesting metal-working operation. They make a horizontal bandsaw, with a platen similar to that of a planer, which is used for trimming the uneven edges of flanged boiler plates. A flanged

tube sheet, for instance, is bolted to the platen, and the machine started up. The feed of the platen carries the tube-sheet against the saw, which trims it off to a uniform height. The wheels, carrying the saw blade, are, of course, vertically adjustable so as to adapt it to all kinds of work within its range. The machine takes work 9 feet long by 6 feet wide, by 2 feet high, and weighs about 25,000 pounds.

There are three methods of sensitive governing under high heads. The first is by means of stand pipes, into which the flow of water is diverted when shut off from the wheel, relief valves being also provided. The second, which is used largely in the U. S., is to deflect the jet or stream away from the buckets, sudden changes of speed in the centrifugal governor bringing a nozzle deflecting mechanism into action. The third is a method introduced by Mr. E. F. Cassel, in which the wheel is divided along the center line of the buckets into two sections, and the centrifugal force developed in the rotation of the wheel body itself is arranged to cause the two sections to separate slightly. A portion of the water jet is thus allowed to pass between the buckets, instead of impinging directly against them, and being part of the wheel itself, the governing action is instantaneous.—*Page's Magazine.*

The use of oil for laying dust on railways and highways has been successful in a certain sense although the cost is perhaps a serious bar to the general mitigation of the dust nuisance on dusty roads. The automobilists also complain that oil is detrimental to their tires because of its well-known destructive effects on rubber. Calcium chloride has been suggested as a cheap and harmless product for laying dust, it being effective for this purpose because of its hygroscopic quality which makes it collect moisture from the atmosphere during even the driest weather. Thus if mixed with the soil of a road bed it soon makes it damp and maintains it in that condition. Although cheaper than oil it doubtless is not nearly so permanent in its effects, and after every heavy rain it would probably have to be renewed. This is one of the valuable features of petroleum, and when used in sufficient quantities it makes a roadway waterproof the same as asphalt

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The Krupp Works, Germany, according to a consular report by Consul-General Richard Guenther, employed at the time of its last published statement, 45,289 men, of whom 4,190 were officials. The average daily wages in the steel works at Essen for the past fifty years is as follows:

AVERAGE DAILY WAGES IN KRUPP CAST STEEL WORKS, 1853-1903

Year.	Daily Wage.
1853	$0.32
1860	0.49
1870	0.73
1875	0.93
1879	0.72
Year.	**Daily Wage.**
1890	$.85
1900	1.14
1901	1.00
1902	1.08
1903	1.09

In a paper read by President F. C. McMath at the tenth annual meeting of the Detroit Engineering Society, on the progress of railway bridge building, the author stated that the last two decades had seen great changes and improvements in the manufacture of bridges, in common with the improvements that have taken place in other lines of manufacture. Bridge shops are greatly increased in number and in capacity; where fifteen years ago no single concern had a capacity exceeding 2,000 tons of bridge work per month, there are now a number of bridge shops that far exceed this output. For example, the American Bridge Company, at Ambridge, near Pittsburg Pa., has an estimated monthly capacity of 20,000 tons of bridge work. One of the most important departments in bridge building is the drafting room, and some idea of the scale of the concern just mentioned will be gained when it is known that provision has been made in the office for upward of 500 draftsmen.

In a paper recently read by Mr. John C. Anderson before the Louisiana Engineering Society, on steel-concrete construction, the author made a special point of the firmness with which cement mortar adheres to steel. In his opinion this union is something different from mere adhesion, being more like fusion of the particles of concrete with those of the steel surfaces. The affinity is such that there is a stronger bond between the cement mortar and the steel than there is between the particles composing the mortar itself. This will be noted when concrete is cut away from a steel beam, for the chisel will cut into the beam without causing the concrete to flake off. When it breaks loose it tends to take the metal with it, there being no well defined line of cleavage, so to speak. Another valuable feature of combined steel and concrete construction is that steel and concrete have practically the same coefficient of expansion by heat, which feature is particularly valuable in the insulation of steam pipes, or in any construction where steel or iron are subject to extreme conditions of temperature.

A spirally corrugated boiler tube is a product which is being offered to American railways as a panacea for boiler troubles. The tubes are made plain at the ends for a distance of about 8 inches, and the body is corrugated in spirals of 3¾ inches pitch. These corrugations render the tube elastic, so that expansion and contraction is taken up within the tube itself without throwing severe stresses upon the tube sheets. It is claimed that a 16-foot tube was stretched ⅜ inch without giving it a permanent set. Hence it may be expected that the ordinary expansion and contraction of a tube in service will be compensated in the tube itself without disturbing its connections with the tube sheets which, as is well known, is the prime cause of most tube troubles. A serious objection to these corrugations, however, would appear to be in the corrugations collecting cinders, but it is claimed that there is no trouble experienced from this source whatever. The increased area of the tube due to the corrugations and their angular projections make such flues more efficient in the transmission of heat, it is claimed, so that there is a marked saving in fuel by their use.

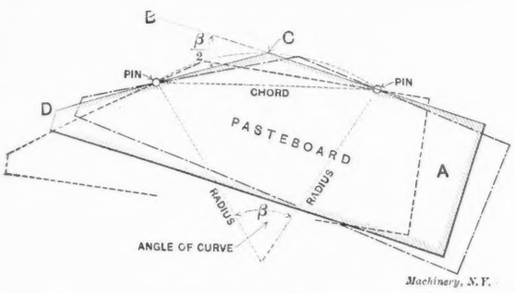
Undoubtedly when all points of advantage and disadvantage are considered the nut-lock *par excellence* for machinery is the double nut with a cotter pin through the bolt back of the second nut. There are, however, some points regarding the size and shape of the second nut that should be recognized and applied to get the best results. It should be made thin, say two-fifths the thickness of a standard nut, and should be chamfered on the bearing side so as to bear heaviest next the thread. Made in this way the lock nut wedges more firmly in the thread and the main nut has less tendency to loosen it under the influence of vibration. A nut-lock has recently been patented in England which is a further extension of these principles. The second nut is made thin and is much smaller across flats than the standard nut. Although it is difficult to understand how a patent was granted for this idea, which has undoubtedly been used time and time again, we must admit that the principle is one that has received little recognition. The smaller nut having less weight than the main nut is less affected by vibration because its frictional hold is greater in proportion to its mass. Hence a vibration which might tend to loosen the main nut only causes it to wedge more tightly against the lock nut, because this remains firmly in place.

Because of the practical impossibility of automatically weighing "run-of-mine" coal when delivered into the tenders of locomotives at coaling wharfs, there has never been a systematic accurate weighing out of fuel to locomotives on American railways, the general plan being the hap-hazard method of estimating the weight from the size of the tender and its condition previous to being filled up. Hence, scarcely any road knows exactly what a class of service is costing for fuel or how any two classes of locomotives compare in the matter of fuel economy. When it is known that coal is one of the biggest items of cost in railway operation it seems lax to

allow this condition to continue. Although run-of-mine coal cannot be accurately weighed on automatic scales such as are used for weighing grain, etc., there is no trouble in weighing in this way coal that is regular in size. This leads a correspondent in the *Railway Review* to call attention to the fact and to the obvious economy that would result in every railway providing coal crushers for reducing all locomotive fuel to an even size. All large power plants regard the coal crusher as a most necessary part of their equipment; crushed coal is easier to handle and is more economical to use since it can be spread more evenly over the grates and combustion is more nearly perfect. Smoke is reduced and the full area of the grates is more nearly utilized.

METHOD OF PLOTTING CURVE FROM AN INACCESSIBLE CENTER.

Correspondents of the *Engineering News* have revived or rather called attention to a useful method of plotting a curve of long radius when the center is inaccessible. Two pins are stuck into the drawing board at the ends of the required curve, and a piece of pasteboard *A* is cut so that the exterior angle *B C D* is one-half that of the required arc. Thus, if the



angle subtended at the center is 40 degrees, angle *B C D* would be 20 degrees. To lay off the curve the pasteboard is pressed against the pins, as shown in the sketch, the points of the curve are marked off from the vertex *C*. The hatched lines show the position of the pasteboard templet and the dotted lines, other positions that it occupies as the points are laid down.

DEVICE FOR PREVENTING EXPLOSIONS OF GASOLINE AND OTHER INFLAMMABLE LIQUIDS.

A consular report from United States Consul Halstead at Birmingham, England, describes an invention called "nonex" which is a device for preventing the explosion of receptacles containing highly inflammable liquids like gasoline, benzine, etc., which give off explosive gases. The consul says that the device is an application of the principle of the Humphrey Davy safety lamp used in gaseous mines, supplemented by a fusible cap or plug. "If a vessel of ordinary type containing an explosive liquid be subjected to sufficient outside heat, or if the contents be lighted at the orifice, the walls of the tank will burst by the force of the expansion. At an exhibition given by the Non-Explosive Device Company, a 20-gallon tank was partly filled with gasoline and placed upon a lighted bonfire. The fusible screw cap, made in two parts which were simply soldered together, soon blew out, the solder having melted, and the ascending vapor caught fire immediately; but no explosion followed, because the orifice of the tank formed the upper end of a tube which projected down inside the vessel to its bottom, where it was closed. To allow the oil or gas to percolate from the interior of the tank each of the metal layers of which this tube was composed had been perforated, and, while the perforations would permit the spirit to be poured out, they prevented the passage of the burning gas to the interior by absorbing its heat as the wire gauze does in the Davy lamp. While the gasoline contained in the tube burned, the flame did not extend to the liquid or accumulated vapor in the half-full tank. The flame was easily extinguished with a bundle of rags and then lighted and put out several times. A motor car tank to which the device was affixed was lighted with a match and extinguished at will. A gasoline can without the device exploded almost instantaneously when lighted."

INDIFFERENCE OF GERMAN WORKMEN TO SPORTS.

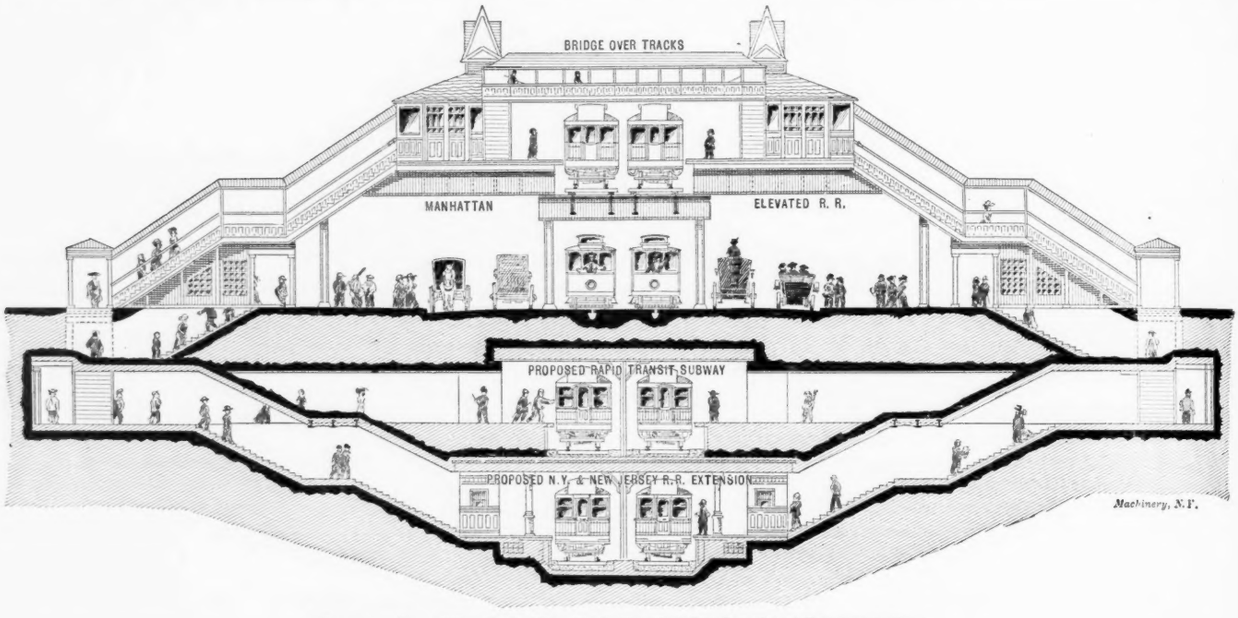
A correspondent of the London *Times*, who has written a series of reports on industrial conditions in Germany, notes a conspicuous difference in the national characteristics of the English and German workingmen as regards amusements. He says: "Amusements play a comparatively small part in the lives of German work people, and such as they have are mostly confined to Sunday. Games have not taken hold of them; they go to no football or cricket matches, although there are matches, and other classes in Germany show a growing taste for games and sports. I went to see a football match between Düsseldorf and a neighboring manufacturing town. It took place on Sunday afternoon. The day was fine and the ground very handy to both towns. A similar match anywhere in manufacturing England would have attracted from 10,000 to 20,000 sons of toil, who would have shouted themselves hoarse from beginning to end. At the German match not one put in an appearance. When I left the field toward the close of the game the spectators, who had slowly increased during the afternoon, numbered exactly 65. They were not workingmen, and they showed no excitement whatever. I noticed a curious difference in the behavior of spectators and players. In England the former keep up an almost continual noise, shouting at nearly every kick, and bursting into a prodigious roar when a good point is made; the players, on the contrary, maintain an almost unbroken silence. It was just the opposite in Germany; the spectators only raised a feeble sound when a goal was kicked, and for the rest were silent, but the players called out incessantly, directing, exhorting, and reproaching each other. They played the association game, not very well. The national game in Germany is kegel, a kind of skittles, and it is played at public houses, but not by workingmen, or seldom by them. They play cards sometimes, but not a great deal. In short, games may be ruled out as an item in industrial life."

REDUCE PRESSURE TO SAVE GAS.

It is a matter of quite general knowledge that there is a certain gas pressure at the burner tip that should not be exceeded if the most light per cubic foot of gas consumption is desired, an excess pressure means that gas is blown away and wasted. The most economical pressure, says Mr. Walter J. May in the *Practical Engineer*, is 0.3 inch water gage, or 0.25 inch if the rooms are not drafty. In the mains the pressure will be anywhere from 0.9 to 4.0 inches, which pressures will be reduced somewhat at the burner tips according to the internal condition of the service pipes. With smooth pipes the reduction is slight, but with rough pipes the loss in pressure is often large. It is a matter of substantial economy to use only pipes of fairly large capacity which are smooth internally and, in fact, cold-drawn pipes are recommended. A "wrinkle" in the economical use of gas is mentioned which is worth knowing. As everyone knows, a stop cock is placed on the supply side of the meter, and no matter whether this is fully or partially turned on, the gas in the meter is the same as on the supply side of the stop cock when the gas is not in use, but if in use the gas expands in the meter if the stop cock is turned on just enough to meet the demand at burner pressure, and this is a big loss to the consumer. To convert this loss to a gain, have a stop cock on the consumer's side of the meter, turn on the one on the supply side to its full capacity into the meter, but regulate the supply to the burners by the stop cock on the consumer's side, and take advantage of the expansion for your own benefit. In many cases this will bring down the gas bill by from 25 per cent. to 50 per cent., but attention must be paid to the regulation. As a matter of actual practice, the gas enters and fills the meter at the main pressure, say 2.0 inches; the amount required is fed into the consumer's pipes at this pressure, reducing the pressure to, say 0.3 inch at the burners, and the reduction thus obtained is obtained by the expansion of the gas in the pipes, the gain being the difference in volume in the gas—*i. e.*, the meter registers the compressed gas—which in the meter is at 2.0 inches—while the consumer uses it at the pressure most economical, and not only saves gas, but what is equally as important, gets more light by reason of the more perfect combustion.

PROPOSED FIVE LEVELS OF TRANSPORTATION IN NEW YORK.

New York, which now grows in a vertical direction because of the natural limitations of Manhattan Island, must also provide transportation facilities on more than one level in order to handle the great volume of traffic during the rush hours. In other words if the skyscraper office building shall eventually monopolize the business section, the city railways must also be built on the same plan, one above the other three and even four "stories" high. For some years the elevated and surface lines have carried the crowds in a fashion more pleasant to contemplate than to experience, and soon the subway will be opened, thus giving elevated, surface and sub-surface transportation lines traversing the city in a general north and south direction. That there will be still another level of transportation is also a possibility if the plans of the New York and New Jersey Railroad Company assume concrete shape. This is an extension or feeder of the Hudson River tunnel north from Hudson St. to the intersection of Broadway and Sixth Ave., which at that part of the route will be a sub-subway or a tunnel underneath a proposed spur of the Rapid Transit Subway. The New York *Herald* recently published an interesting diagram showing in a vertical section the four levels of railway lines at the intersection of Sixth Ave. with Broadway at Thirty-third St., and a fifth level above all in the shape of a foot-bridge over the Thirty-third St. station. This is, of course, an extreme condition, but it gives some idea of the great traffic and future plans for handling it.



Cross-section of Tracks in New York showing five Levels of Transportation.

REMEDY FOR INJURED STEEL.

La Revue Technique, July 10, 1904.

Messrs. Stead and Richards, of England, have developed an exceedingly simple process for the amelioration of steel that has been injured, burned or rendered brittle in the course of manufacture. Large masses of steel that are to be forged or rolled are heated in a reheating furnace before being subjected to these operations. It is essential that they should be raised to a certain temperature, which must not be too high, for otherwise they are apt to be burned, as it is called, and such burned metal is so modified in its characteristics that it will frequently break to pieces when passing between the rolls. It is generally recognized that, to obtain the best results, the temperature of this reheating should not be above 2,200 degrees F. Now Messrs. Stead and Richards have found that steel, which has been rendered useless by having been overheated and crystallized can not only be brought back to its original condition, but can even be improved by a treatment developed by them, which consists in heating the metal after it has cooled, to a temperature of from 1,550 degrees to 1,650 degrees F. It is of the first importance that this latter temperature should not be exceeded. Further than this, the process is perfectly efficacious in healing, if we may use the term, those steels that have become crystallized in service, and after the treatment they are better than when they left the forge in the first place. We know that the object of forging is to do away with this coarse crystalline structure, and when it is found to exist in a metal, we have, up to the present, known of no other way than re-forging to restore the fine texture. Messrs. Stead and Richards maintain that their method possesses the same advantage and, furthermore, that it materially increases the tensile strength, frequently as much as 100 per cent.

It should be noted, however, that the inventors do not make these claims for mild steel, but for the better qualities used in crankpins and similar places. G. L. F.

THE AEROPLANE AND FLYING MACHINE.

Abstract of Paper read by Major B. Baden-Powell, President of the Aeronautical Society, before the British Association.

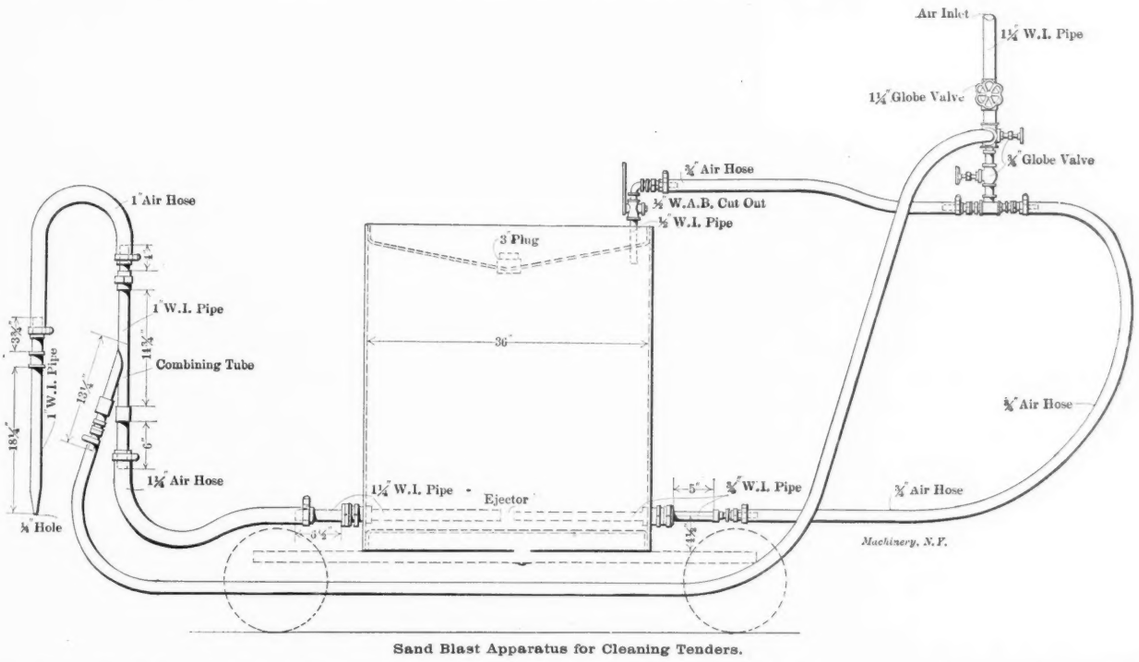
The day is undoubtedly drawing near when we shall be utilizing the highway of the air for travel, and it is becoming an interesting question as to what form the motor-car of the skies is to take. A great number of abortive attempts to produce a practical apparatus have thrown considerable light on the prospects. During the last few years we have seen a great development in the construction of navigable balloons, and, in my humble opinion, these many attempts have only shown clearly what immense difficulties have to be contended with, and how little hope there is of our obtaining any real success in this direction. I do not wish to imply that the navigable balloon is an utter failure, and though such a machine may prove itself most useful on certain particular occasions, and for special purposes, such as military observation, even that is a long way from being a really practical conveyance, capable of going up in all weathers, and stemming such winds as it may be likely to encounter on any average day. A balloon must of necessity be of huge size, and it must, therefore, offer a great resistance to rapid propulsion. Speed, however, is everything in practical aerial navigation, since the great object is to be able to progress in a given direction without interference from the wind force. If the same propelling power were applied to some smaller form of apparatus, would it be possible for the machine to maintain itself in mid-air, and progress through it? Theory answers very decidedly, Yes, and even practice may point to many promising results. The aeroplane (using the word in its widest sense) may be defined as a plane, or nearly plane, surface propelled through the air in such a manner that the resulting pressure acts so as to support it against the action of gravity. The

frontal resistance of such a plane, even of very large surface, seems bound to be less than that offered by a large balloon, and it should, therefore, be able to travel quicker.

Devices for attaining artificial flight may usually be classed under one of three headings—(*a*) wing action, similar to a bird's flight; (*b*) vertically-acting screws to lift the weight upwards; (*c*) aeroplanes proper, or plane surfaces propelled horizontally, with a slight upward inclination. All these three, however, are but aeroplanes according to the above definition. The wing is but the aeroplane moved up and down. The vertically-acting screw is but a pair of small aeroplanes moving round a common center. What we have, then, to study, is the action of air on inclined surfaces, and this is a subject not at all well understood. Theory and practice are much at variance. Theorists have worked out their problems, and shown what is, or should be, possible; but practice has been unable to even approximate the attainments suggested. Take the thrust of aerial screw propellers. The following are some of the records I have been able to collect:

Nadar in 1863, as the result of small experiments, computed that a thrust of 33 pounds should be got from 1 horse power. Wenham, with a spring motor calculated on 33½ pounds per horse power. Dieuiade, with a small steam engine got a pull of 26.4 pounds; and Forlanini made a little engine giving exactly the same results. Vogt, a marine engineer, made some careful comparisons between aerial and submarine screws, finding the former produced 33 pounds thrust per horse power. Later, with large screws rotated by manual power, he calculated that he got 55 pounds per horse power. Yet, when we come to trials on a large scale, we find Maxim, with his great steam engine of 360 horse power and screws of 17 feet 10 inches diameter, only gets a thrust of 2,000 pounds, or at the rate of 5.7 pounds per horse power. Santos Dumont, taking the best of aerial engines tried, obtains a pull of 175 pounds with 16 horse power, or 11 pounds per horse power. Zeppelin, with two engines of like power, only gets 220 pounds thrust, or 7 pounds per horse power. With my own little petrol motor of 1½ horse power I have only been able hitherto to get 5 pounds pull out of the screw. It is true that Walker, in his experiments with large propellers, shows from 11 pounds up to no less than 74 pounds; but these, again, may be classed as laboratory experiments. Then it has been usual for theorists to consider only the pressure of the air on the under surface of the plane. But recently a little more light has been thrown on the subject of what we may call the lack of pressure on the upper side, which undoubtedly has a considerable effect in sucking the plane upward. Even the pressure of the air acting on a plane surface moving in a normal direction—that is to say, so that the air strikes it perpendicularly, has been variously measured. All the older textbooks give the formula thus: Pressure = velocity ^{2} × .005. But the more recent experiments of Langley, Renard, Dines, Stanton, and others vary from .0027 to .0039, showing a very marked and important difference from the old formula. Commandant Renard made many trials at the French Military Aeronautical Establishments. But the results, which have not been published in full, seem to have been very variable, ranging between 48 pounds and 17 pounds per horse power. He remarks, significantly, that some forms of screw are so much more efficient than others, and that there must be "a screw very much better than others, and its form cannot be much departed from without producing very bad aerial screws."

Another matter of importance on which authorities disagree is that of skin friction. Hitherto it has been supposed that the friction of the air on surfaces moving rapidly through it was negligible. Thus Langley, in his "Aerodynamics," says: "The friction of the air is inappreciable—this fact may be stated as the result both of my own experiments and of well-known experiments of others." Maxim, making his experiments with aerial screws, tested a contrivance like a screw propeller, but with perfectly flat blades, the results of which were that he found "the skin friction between the air and the polished surface is so small that it need not be taken into consideration." It might then have been considered that this point was settled. But no. Within the last few months Mr. Zahm read a paper before the Philosophical Society of Washington, giving an account of a series of careful experiments he has made, which seem to prove that the frictional resistance is at least as great for air as water in proportion to their densities. In other words, it amounts to a decided obstacle in high-speed transportation.



Sand Blast Apparatus for Cleaning Tenders.

SAND BLAST APPARATUS FOR CLEANING TENDERS.

Railway Age, September 2, 1904, p. 303.

A method of sand blasting locomotive tenders for repainting has been in use at the Scranton shops of the Delaware, Lackawanna & Western for some time with marked success. The illustration shows the connection and form of the sand ejector, combining tube and nozzle. To bring the sand out in better quantities, air pressure is maintained within the tank. The ejector consists of two iron pipes, with open ends opposite, the blast passing from one to the other and carrying sand with it. The combining tube consists of two iron pipes welded at an acute angle, so that an unencumbered air cur-

rent at full pressure enters the sand passage and supplies additional force. The nozzle is a 1-inch iron pipe drawn down to a ¼-inch opening. The nozzle and combining tube wear rapidly but are cheaply made and easily attached.

As to results, one man can clean a 6,000-gallon tank on the trucks, as run in, in from six to ten hours, depending on its condition, quality of sand and constancy of air pressure. The latter is an item not to be overlooked, for in a shop which ordinarily works about to the limit of its air supply such a blast as this is capable of making quite an inroad. Here a good grade of lake sand is used, and it is generally used over, but after the first blasting it loses much of its sharpness and therefore requires a longer time to do the work. However, an average of about 1 square foot cleaned per minute is made. The surface obtained is ideal for painting, as it is just rough enough to hold the primer nicely.

STEAM AND ELECTRIC TRACTION COMPARED.

Railway Age, September 2, 1904, p. 290.

The impressive exhibition of power manifested by the steam locomotive with its heavy blast of smoke and sparks from the stack is quite in contrast with the electric car or locomotive, which starts and moves with so little appearance of effort. The consumption of power for obtaining the same result with trains of equal weight and speed will, of course, be nearly equal with either form of motor. The modern passenger locomotive develops 1,500 to 2,000 horsepower for a considerable period, and, in fact, this amount is often required to move trains of 600 tons at speeds called for by fast schedules. A large amount of power is required to move the locomotive itself at high speeds on account of the head-end atmospheric resistance. For this reason, only a fraction of the total tractive effort developed appears at the drawbar as useful work for hauling cars. The same is true of the electric car or locomotive, so that it may be said that the principal element of resistance at high speed is common to both kinds of traction.

As an indication of the power required to move a single electric car at even moderate speed, the following figures are given:

	Car, Length, Feet.	Weight, Pounds.	Speed, Miles per Hour.	Motor Horse Power.
Aurora, Elgin & Chicago.....	47	75,000	65	500
Columbus, London & Springfield	60	75,000	65	500
Lackawanna & Wyoming Valley	52	70,000	60	300
Rockford, Beloit & Janesville..	46	52,000	45	200

From these figures, which do not represent abnormal cases, it is apparent that from 300 to 500 horsepower is frequently placed under cars having total light weights not exceeding 75,000 pounds, this weight including, of course, the motors. Passenger trains of 600,000 pounds weight are frequently handled by locomotives weighing, engine and tender, over 300,000 pounds, and capable of producing 1,800 horsepower for short periods. This is a ratio of 1 horsepower to every 500 pounds total train and engine weight. With 500 horsepower under an electric interurban car, the ratio is about 1 horsepower to every 150 pounds per car. As all the weight can be used for adhesion and as the rotative force is uniform, the wonderful acceleration and high speed of these cars are therefore easily explained.

We have alluded to loss of power due to great air resistance at high speeds, and it is a fact that, under such conditions, this resistance being almost entirely overcome at the head end of the train, it has been deducted from the power otherwise available at the drawbar. This cannot be charged as a loss against the steam locomotive, for if the engine were absent and the power were supplied by motors the train would create the same resistance.

The operative loss due to dead weight of the locomotive, as compared with electric motor drive, is not as great as many followers of electric traction imagine. With a total engine and train weight of 900,000 pounds, about one-third may be due to the engine and tender. Upon high-power interurban electric cars the weight of the motors and controllers will amount to about one-third of the whole weight, in some cases. Therefore, so far as consumption of power used to move the motive mechanism is concerned, electricity has little advantage over steam, and but for the power consumed in hauling the fuel and water, the difference would be the other way. The great advantage, therefore, lies almost solely in the fact that the total weight of the train and its load is available for adhesion, permitting the use of enormous power. When adhesion is adequate, the steam locomotive operates under conditions far less wasteful than is conceived by many believers in the ultimate supremacy of electric traction.

The electric motor is a less delicate piece of mechanism than the locomotive; it can be worked much harder and more continuously than is possible with its predecessor, and it has, moreover, only about one-third as much internal friction. The electric locomotive is double-ended and requires no turntable. Two electric locomotives can be coupled together and operated by one engineer in the cab of the leading locomotive, each one doing its share in hauling the train. It is not necessary to consider the use of the firemen in electric propulsion, and it is on the fireman's side and not the engineer's that most of the objection to the steam locomotive arises. The disadvantages of the steam locomotive relate largely to the boiler losses and to the smoke and spark nuisance. It is standing idle a good part of the 24 hours of the day, and it is necessary to allow for coal wasted in making up and dampening the fires and the general waste incident to a locomotive when fired up but not running. It is called upon to operate at the varying temperature of the surrounding air, the coal consumption during winter months being often more than 25 per cent. in excess of that during the summer months, hence 12 to 15 per cent. additional is charged to the steam locomotive for this loss in any comparison in fuel economy with the electric power station.

* * *

The International Steam Pump Co. report the excellent performance of a Worthington pumping engine installed at the Park Avenue pumping station, Chicago. The engine is of the duplex, reciprocating, triple-expansion type, having semi-rotary steam valves, but no flywheel. The latter is replaced by compensating cylinders so arranged that their pistons retard the motion of the main piston during the first part of the stroke, but assist it towards the close, giving a uniform resultant thrust. The pistons of these auxiliary cylinders work against air under pressure from a tank. The engines are vertical and the weight of the pistons, plungers and rods is counterbalanced by another auxiliary balancing plunger, also working through the medium of water against air under pressure.

The capacity of the engine is about 22,000,000 gallons per day against a total head of slightly over 121 feet, and 660.9 horse power were indicated in the test. The duty obtained was 174,735,801 foot pounds per 1,000 pounds of steam used, corresponding to an economy of 11.32 pounds of steam per net horse power delivered in water lifted, or 10.01 pounds of steam per indicated horse power. The steam pressure was 144.45 pounds per square inch, with 154 degrees F. superheat at the throttle, the steam cylinders being provided with jackets and reheaters.

* * *

CHARTS IN DESIGNING.—2.

THICKNESS OF CYLINDERS.

JOHN S. MYERS.

Suppose it is desired to have a chart which will give the thickness of cylinders for various pressures, sizes and materials.

For thin cylinders not having a seam or joint the formula is, $t = pd/2s$, where t = thickness in inches, p = pressure in pounds per square inch, and s = allowable working stress. For thick cylinders, Burr, in his "Elasticity and Resistances of Materials," page 36, gives $t = r\left\{\left(\frac{h+p}{h-p}\right)^{\frac{1}{2}} - 1\right\}$; in which r = interior radius, h = maximum allowable hoop tension at

the interior of the cylinder, t and p having the same values as before. Rankine gives $R = \sqrt{(s + p/s - p)} \times r$, in which R = exterior radius, s, p and r having the same values as before. Lame gives $t = r(\sqrt{s+p/s-p} - 1)$. Merriman gives $t = rp/s - p$. Changing the notation and solving for s/p, the Burr, Rankine and Lame formulas solve out to the same form, $= s/p \dfrac{(t/r+1)^2+1}{(t/r+1)^2-1}$; Merriman's formula solves out to $s/p = r/t + 1$; for thin cylinders, $s/p = r/t$.

Inserting values of t/r in the Burr, Rankine and Lame formulas, the corresponding values of s/p may be calculated.

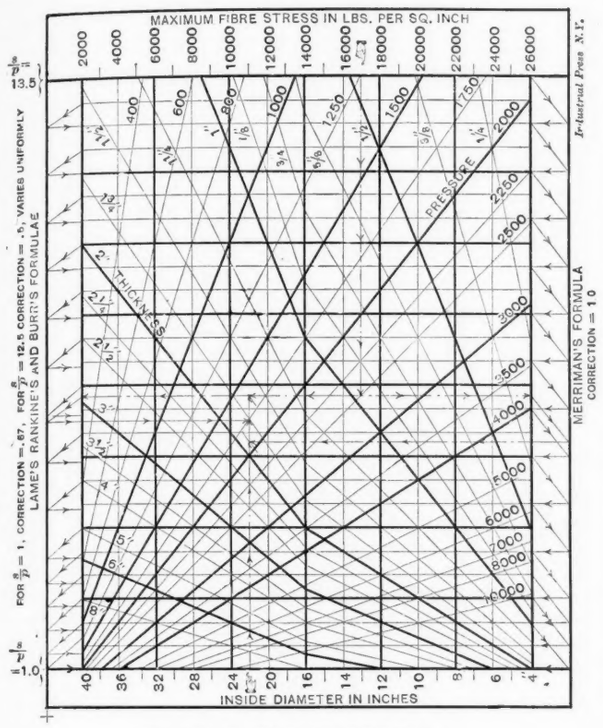


Chart No. 8. Thickness of Cylinders.

NOTATION.

Notation—d = inside diameter, r = inside rad., t = thickness of walls, S = maximum fiber stress, P = pressure per square inch. Inside cylinder, $t = \dfrac{Pr}{S}$, for thin cylinders. For thick cylinders, Rankine, Lame and Burr's formulas solve out to the same form: $t = r\left(\sqrt{\dfrac{S+P}{S-P}} - 1\right)$, or $\dfrac{S}{P} = \dfrac{\left(\dfrac{t}{r}+1\right)^2+1}{\left(\dfrac{t}{r}+1\right)^2-1}$. Merriman gives: $t = \dfrac{rp}{S-p}$, or $\dfrac{S}{P} = \dfrac{1+\dfrac{r}{t}}{1}$. Example: S = 17,000; P = 2,500; d = 22″. Following broken line, t = 1⅝″ for thin cylinder; t = 1¾″, Rankine's formula; t = 1⅞″ by Merriman's formula.

Lay out the chart for thin cylinders, choosing for the first factor at the top of the chart, s, and for the second factor $1/p$; their product, s/p, is represented by a uniform scale on the sides. See chart No. 8. The minimum reading has been chosen as 1, and the maximum reading as 13.5; each space represents 0.5. On the bottom lay off values of r, which have been chosen from 2 inches to 20 inches and doubled to read diameter instead of radius. This radius is considered a first factor commencing at the bottom of the chart, the second factor being $1/t$; their product is r/t, which is equal to s/p and is represented by the same scale at the side.

Since tracing from stress to pressure and thence to the side of chart strikes the same value as tracing from the diameter to thickness and thence to the side, they must intersect at the required thickness. The example illustrated by the broken lines is, stress = 17,000, pressure = 2,500, diameter = 22 inches; the intersection shows the thickness to be 1⅝ inch, according to formula for thin cylinders. In Merriman's formula $s/p = r/t + 1$, hence a correction of 2 spaces of .5 each is made at the right side, and in the above example the intersection shows the thickness to be 1⅞ inch. The corrections on the left side for Burr's, Rankine's and Lame's formulas are laid off from calculated values previously referred to. The example indicated shows the thickness according to this formula to be 1¾ inch, which is probably the most reliable as being based upon a more nearly perfect theory. It may be noticed that in calculating the corrections for Lame, Rankine and Burr's formulas the values inserted were t/r while the values of the scale on the left of the chart are r/t. This is rectified by the use of a table of reciprocals when plotting these corrections.

Steam Engine Proportions.

Chart No. 9, embodying in 24 subdivisions lettered a to x the proportions for the various parts of steam engines, illustrates how charts may be used to condense data too voluminous for ready reference, at the same time showing relations of parts in such manner that interpolation between values is facilitated. In Kent's Pocket Book will be found a rather exhaustive comparison of the Rankine, Seaton, Unwin, Thurston, Marks, Whitman and many other formulas on the subject of engine proportions, giving average results solved out for six different sizes of engines. These sizes form the basis of this series of charts. The general data of these engines is given in Table 3.

Chart a shows comparative piston speeds; chart b, indicated horsepower; chart c, mean effective pressure, the maximum pressure for all three being taken at 100 pounds per square inch. In b a change of scale has been made in order to save space; d and e show thickness of metal for cylinder and cylinder heads, respectively. It is probably the best practice to make the latter double on large sizes instead of using such thickness as shown. f and g give size and number of cylinder head studs. The curve in f is distorted at the lower end on account of inadvisability of using studs smaller than ¾ inch except on very small engines. h gives piston thickness, curve A being for the shorter and curve B for the longer stroke engines, the piston speed of which were equal for equal diameters of cylinder. i gives breadth and thickness of cylinder rings according to an empirical formula. j gives diameter of piston rods, A being for the short and B for the long stroke engines. k gives diameter of center for round connecting rods, and l and m give thickness and depths for rectangular rods, the length of rod in both cases being 2½ times the stroke. n gives area of piston rod guides or crosshead slippers. The scale has been varied in order to save space. o and p give diameter of crankshaft for center crank engines, o being the shaft transmitting the twisting moment as well as withstanding the bending action due to thrust; while p is the shaft carrying this bending action only. q gives proportions for over-hung crank pins, DA, DB and LA, LB being respectively diameters for short and long stroke and

TABLE 3. STEAM ENGINE DATA.

		Short Stroke Engines.			Long Stroke Engines.		
Indicated horse-power	I. H. P.	50	450	1250	50	450	1250
Diameter of cylinder in inches	D	10	30	50	10	30	50
Stroke in feet	L	1	2.5	4	2	5	8
Revolutions per minute	r	250	130	90	125	65	45
Piston speed in feet per minute	S	500	650	700	500	650	700
Area of piston in square inches	a	78·54	706.86	1963.5	78.54	706.86	1963.5
Mean effective pressure	M. E. P.	42	32.3	30	42	32.3	30
Max. total unbalanced pressure	P	7854	70,686	196,350	7854	70,686	196,350
Max. total unbalanced pres. per sq. in.	p	100	100	100	100	100	100

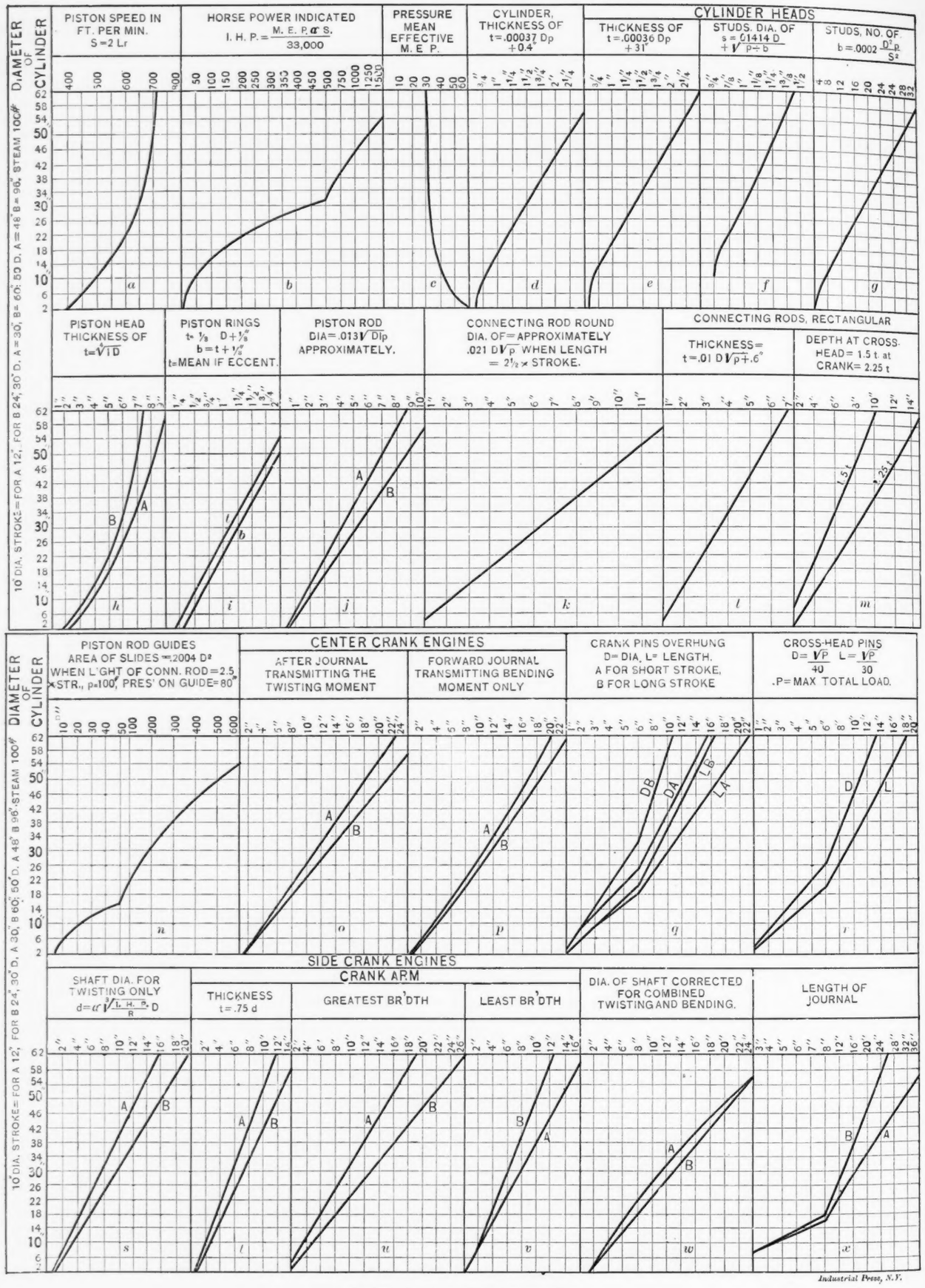

DIAMETER OF CYLINDER
PISTON SPEED IN FT. PER MIN. S=2 Lr
HORSE POWER INDICATED I. H. P.=M. E. P. α S. / 33,000
PRESSURE MEAN EFFECTIVE M. E. P.
CYLINDER, THICKNESS OF t=.00037 Dp +0.4"
CYLINDER HEADS
THICKNESS OF t=.00036 Dp +.31"
STUDS, DIA. OF s=.01414 D √p÷b
STUDS, NO. OF b=.0002 D²p/S²
10" DIA. STROKE= FOR A 12", FOR B 24", 30" D., A=30, B=60; 50 D. A=48" B=96", STEAM 100#
PISTON HEAD THICKNESS OF t=√1.1D
PISTON RINGS t=1/8 D+1/16" b=t+1/16" t=MEAN IF ECCENT.
PISTON ROD DIA=.013√Dlp APPROXIMATELY.
CONNECTING ROD ROUND DIA. OF=APPROXIMATELY .021 D√p WHEN LENGTH = 2½ × STROKE.
CONNECTING RODS, RECTANGULAR
THICKNESS= t=.01 D√p+.6"
DEPTH AT CROSS-HEAD= 1.5 t. at CRANK= 2.25 t
PISTON ROD GUIDES AREA OF SLIDES =.2004 D² WHEN L'GHT OF CONN. ROD=2.5 × STR., p=100#, PRES' ON GUIDE=80#
CENTER CRANK ENGINES
AFTER JOURNAL TRANSMITTING THE TWISTING MOMENT
FORWARD JOURNAL TRANSMITTING BENDING MOMENT ONLY
CRANK PINS OVERHUNG D= DIA, L= LENGTH. A FOR SHORT STROKE, B FOR LONG STROKE
CROSS-HEAD PINS D=√P/40 L=√P/30 .P= MAX TOTAL LOAD.
SIDE CRANK ENGINES
SHAFT DIA. FOR TWISTING ONLY d=α ∛(I. H. P./R) D
CRANK ARM
THICKNESS t=.75 d
GREATEST BR'DTH
LEAST BR'DTH
DIA. OF SHAFT CORRECTED FOR COMBINED TWISTING AND BENDING.
LENGTH OF JOURNAL
Industrial Press, N.Y.

Chart No. 9. Steam Engine Proportions.

lengths for short and long stroke. *r* gives diameter *D* and length *L* of crosshead pins. *s* shows shaft diameter necessary to transmit the torsion only, which is used in proportioning the crank arm. *t*, *u* and *v* give respectively the thickness, greatest and least breadth of crank arm. It is probably a preferable construction to use a crank disk, counterbalanced. *w* gives the diameter of shaft corrected to take care of the combined twisting and bending moments. *x* gives journal length, the pressures on journal ranging from 102 to 196 pounds per square inch.

A SECTIONAL FIXTURE.

RALPH E. FLANDERS.

The casting shown in Fig. 1 strapped to the table of a milling machine is one of a large variety of housings of widely varying shapes and sizes, which are used in the construction of a certain automatic machine. These housings resemble each other in that they are provided with a V-groove at the bottom, where they are clamped to the bed of the machine, and also in the fact that they are made with various pads and bosses, similar on both sides, which have to be milled off to a uniform thickness of 1½ inches. The cross-hatching in the plan view distinguishes the finished areas.

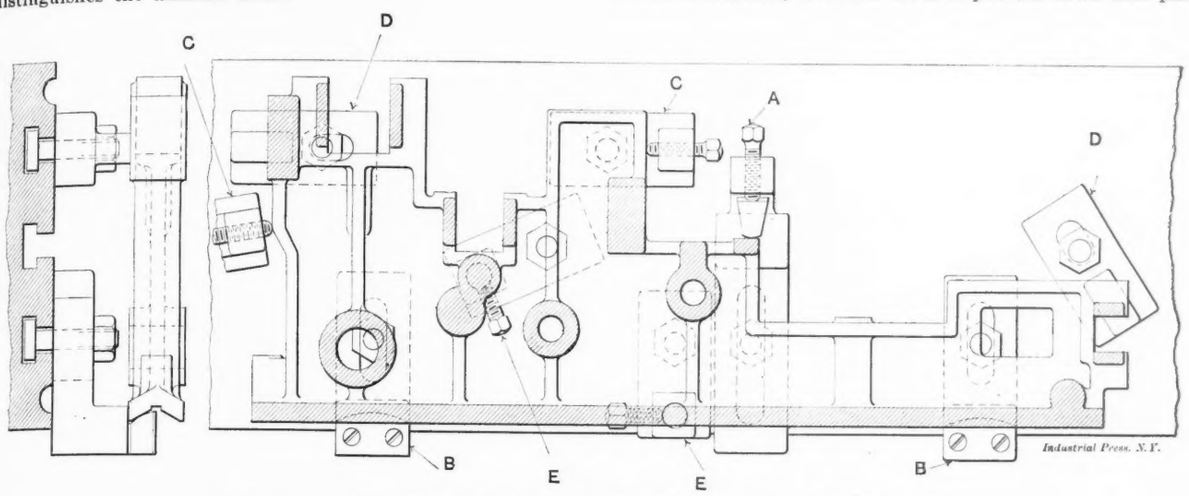


Fig. 1. A Sectional Fixture or Jig Holding a Machine Housing on a Milling Machine Platen.

The large number of patterns used would have made the job of providing a separate fixture for each style of casting a very costly proceeding. After a little thought, we made the hereinafter described sectional fixture, and it has worked well on all the different pieces on which it has been tried.

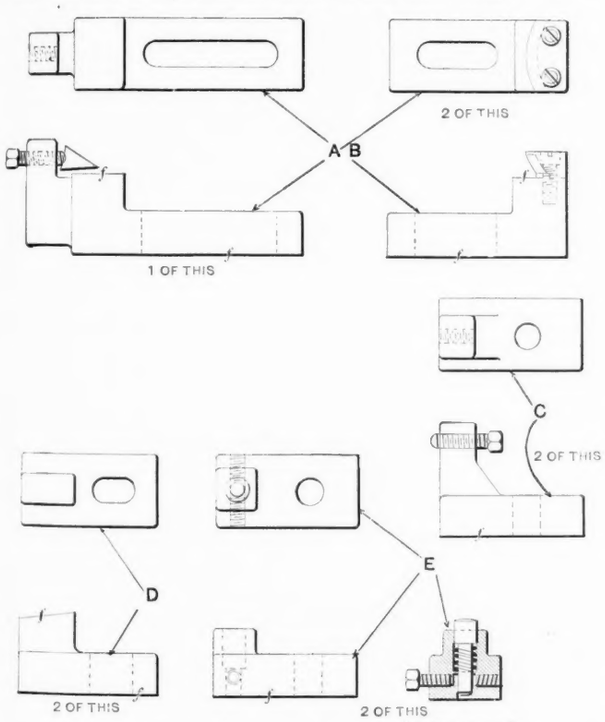


Fig. 2. Parts of the Sectional Fixture.

Fig. 2 shows the different parts of the fixture in detail: *A* is a block with a setscrew and spur, similar to that used on a planer; *B* is an abutment provided with a steel block to enter and hold down the V-groove edge of the casting; *C* is a simple stop to take the thrust of the cut; *D* is a wedge used under springy places in the casting; and *E* is a spring-jack used where convenient for a similar purpose.

In Fig. 1 a typical casting is shown on the milling machine platen with the various holding pieces arranged about it. The two blocks *B* are laid at the outside edge of the table, and the work is supported on these and the spur block *A*, thus giving a three-point bearing for a foundation. The spur holds it down on one side, and the steel blocks in the V-groove hold it down on the other. Blocks *C* with their setscrews are arranged as shown to take up the end thrust in each direction, and wedges *D* are slipped lightly into contact with outlying corners of the work where support is needed. Spring-jacks *E* are also located where the work is most liable to spring under the influence of the mill. These jacks are fastened permanently in place, the setscrews loosened, then the work is pressed down into place and fastened with the spur block *A*. The setscrew, which bears against the teat of the spring plug, is then clamped, and the casting is thus supported without the possibility of the casting being sprung as it would be if fastened down onto a solid bearing which might or might not be of the right height. The setscrew may be placed in either side, as is convenient. See detail of spring jack in Fig. 2.

A 6-inch end-mill is used in the vertical milling attachment to make the surfacing cut. This does its work more rapidly and with less pressure than a cylindrical cutter would. Care is taken to feed in such a direction that the thrust of the cut will be toward the V-blocks *B* or the stops *C*, although when by mistake the cutter was run toward the spur *A*, this seemingly insecure fastening held the work well. These housings are allowed a limit of 0.002 inch over or under the standard thickness of 1½ inch.

* * *

SOLUTION OF THE BEVEL CURVE.

CHARLES CLOUKEY.

A comprehension of the title as given above would require some knowledge of cutter heads upon which the knives or tools are bolted. These are familiar to and used mostly by woodworkers, but are the same as a milling cutter would be if the cutters were bolted to a rectangular head, with the proper extension to make the cut required. In the working of wood moldings it is often necessary to make bevel cuts of some considerable depth, and the operator is surprised to find that his knife which he has carefully ground to the proper bevel, with its cutting edge perfectly straight, does not cut the bevel with a flat surface, but with so great a convexity as to spoil the detail. By experiment he is able to grind sufficient curve on the edge of the knife to correct the error, but by a solution of the puzzle he will be able to lay out his knife properly at the start.

In the illustration is shown the plan of a cutter-head, *a*, from the center of which a perpendicular, *o i*, is dropped to the bed of the machine, represented by the line *b c*. The line drawn along the side of the head in its first position intersects the vertical line at the surfacing cut, *e*, or, in other words, it is where the molding pattern begins, and all calculations are made from this intersection downward.

A careful study of the matter will show that in order to make a knife cut 1 inch deep, when bolted to a 4-inch head, it

must be projected 1 7-32 inches beyond the surfacing line, and to cut 2 inches deep the extension will be 2 5-16 inches, a gain of only 3-32 inch in the second inch of depth, and for the third inch there is little more than 1-16 inch gain, while for the fourth inch the gain is but 3-64 inch.

The trigonometrical reason for the above may be illustrated by the figure, and is contained in the statement that the line *d e* is longer in proportion to the line *o e* than the line *f i* is to the line *o i*. By using the protractor we find that the angle *d e o* is 38 deg., the tangent of which is .7813. This decimal is the ratio between the side adjacent, or *o e*, and the side opposite represented by *o d*. We find the sine of 38 deg. to be .61566, and .7813 ÷ .61566 = 1.27, which represents the hypotenuse, *d e*. Solving the triangle *f o i*, in the same manner, using the angle *f i o* of 16 deg., we find the hypotenuse or the line *f i* to be 1.04, and 1.27 — 1.04 = .23, which shows that the line *d i* is nearly ¼ inch shorter for every inch of its length, in proportion to the line *o i*, than the hypotenuse *d e* is to the line *o e*.

Now as the line *o e i* represents distance from the center of the head straight down to the bed, and the hypotenuse is the

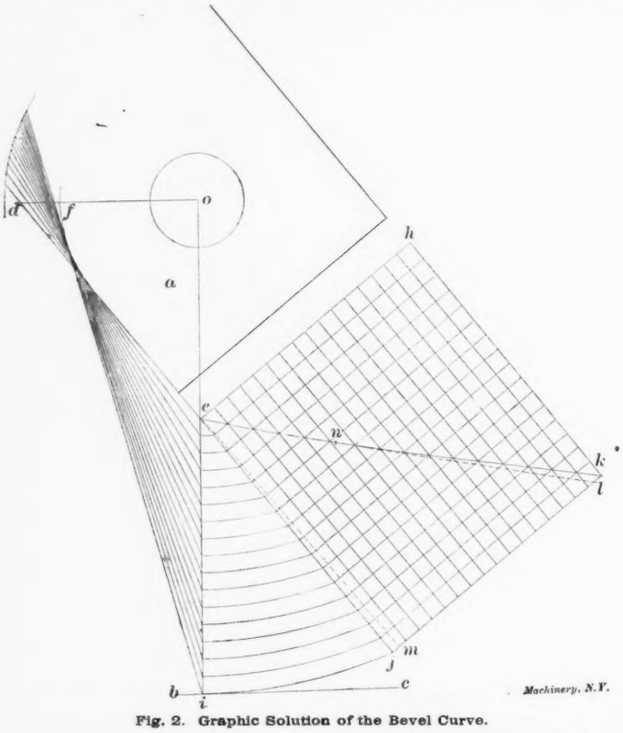


Fig. 2. Graphic Solution of the Bevel Curve.

inner line of the knife, it will be seen that to shorten the latter in relation to the former is to shorten the projection of the knife in relation to the depth of the cut. By using a full-sized drawing and a pair of accurate dividers, and measuring down the line *e j*, the first inch is found to be 11-64 inch longer than the fourth inch, so that if a knife is to be made to cut a bevel 4 inches deep the first inch will require 11-64 inch more allowance than the last, and as the variation is a gradual one it appears at once that the cutting edge of the knife cannot be straight.

Another reference to the figure will show that the knife makes its finishing cut at the vertical line *e i*, no matter what the depth, as this is the point directly under the cylinder, and that when the knife is finishing at *e* the outer end has reached *j*. This discloses the fact that the only straight line a straight knife could make across a bevel would be developed where the knife was actually cutting, and would always be ahead of the finishing line, as each cut practically begins at this line. However, the above knowledge would be of little value to the mechanic except to give him an understanding of his trouble—a diagnosis, if you please—unless a practical method is given for plotting the curve required for the edge of the knife. A still further study of the figure will show that this plot is so simple that anyone can develop it correctly, even though he is ignorant of every trigonometrical function and knows only such arithmetic as is found on his two-foot rule.

Let the point *e* represent the edge of the knife that does the surfacing, and from which point the bevel would start, and from *e* to *i*, which represents 4 inches, lay off in eighths of an inch exactly to the standard scale as found on a rule or square. The line *d e* extend indefinitely, and with *o* as a center describe the arcs from the divisions on *e i* to their intersections with the line *e j*, which gives a new and proportional scale along the line of knife extension. To develop this scale draw the lines perpendicular to *e j*, from the ends of the intersecting arcs, and extend them to the right 4 inches, or indefinitely. Along the line *e h* lay off another standard scale, the same as the one from *e* to *i*, and extend the divisions to the line *j k*. This gives a combination of the standard with the proportional scale, and by drawing the line *e k* 4 inches out and 4 inches down, through the intersections of the lines on the diagram, it will show the required curve.

If it is required to cut a sharper bevel with the same knife the practical limit is shown by the dotted lines, *n l*, on the projection. An attempt to make a vertical cut would necessitate drawing the knife back and using the 4 inches of the outer end, bringing the point *n* in coincidence with *e*. A straight line tangent to the curve at *n* and extended 4 inches diverges ⅛ inch from *k* at *l*, and transferred to *m* shows the limit beyond which the curved edge of the knife would produce a concave surface. The upper part of such a steep cut would be slightly convex for reasons already given.

The illustration and explanation so far have contemplated the use of a head 4 inches in diameter across flats, or between the faces to which the knives are bolted, and the curves for all other sizes of heads would be different, though geometrically similar. This is shown by the fact that the original of the illustration was drawn to a scale of 2 inches to 1 inch, or the same as an 8-inch head, and the printed reduction has the proper curve for the sized head that appears in the figure.

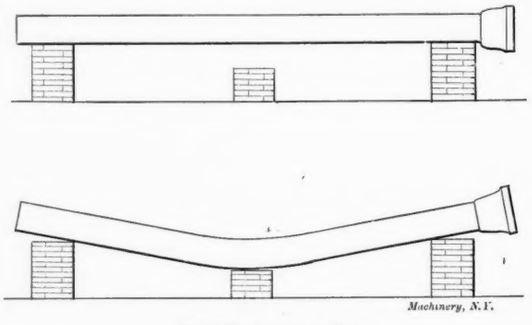
The depth of 4 inches for the cut was chosen for purposes of illustration, as in practice the cuts seldom exceed a depth of 2½ inches.

* * *

BENDING CAST IRON PIPE.

A feature of the twelfth annual meeting of the Pacific Coast Gas Association, held at San Francisco, July 19-20, 1904, was the presentation of a paper consisting of a collection of "wrinkles" contributed by practical men. Mr. T. R. Parker, Napa, Cal., sent a sketch of a method successfully followed in bending cast iron pipe. His first attempt at bending cast iron was at a lumber camp, which he relates as follows:

"Our cook could not bake bread in the stove oven on account of the cross-piece between the lids having become bent or warped so that it allowed too much cold air to pass over his



Bending Cast Iron Pipe.

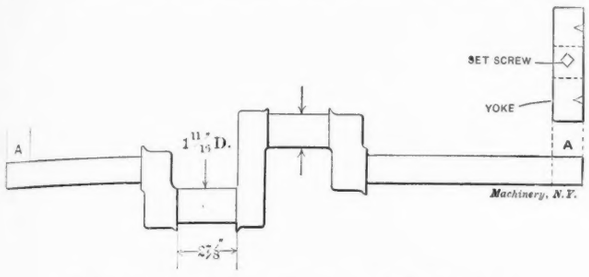
oven. He asked me if I could straighten it. I thought the same medium that bent it could unbend it, so I put it in the forge and got it to a bright cherry red, then placed it on the anvil upside down, and with a gentle pressure from the sledgehammer, brought it down straight again. So when occasion required to swing around a curve with nothing but straight lengths of cast iron pipe to do it with, I have done this, building a fire around two or more pipes, as the case might be, and letting them warp down until the center pier wall touches, then knocking out the fire and using no water to extinguish it. I have made some very pretty bends this way for the water company, withstanding 150 pounds pressure. The wood is piled after the manner that a blacksmith heats his tires."

LETTERS UPON PRACTICAL SUBJECTS.

WHAT IS THE CAUSE OF THIS TROUBLE?

Editor MACHINERY:

In the course of my work I have to turn cast steel crankshafts of the form shown in the sketch. My trouble is that I cannot get them to come round; even after taking a very light cut they will vary from 0.002 to 0.005 inch. They come small-



Why do the Cranks come "out of round" in the Center?

est in the centers of the crank-pin bearings, as indicated by the arrows. The crankshafts are held in yokes at *A A* by setscrews.

I would like to know if anyone else has such trouble, and how it can be helped. W. K.

"STANDARD" NOSE THREADS FOR LATHE SPINDLES.

Editor MACHINERY:

Over thirty years ago, as foreman of a machine shop, I was worried almost to death by the confusion in spindle threads, as chucks could not be exchanged even on lathes of the same size in many instances; so I determined that when I got to my own works that difficulty would be avoided. This was done by selecting a nose thread from each class of lathe—10 inch to 12 inch, 16 inch to 20 inch, 24 inch to 30 inch, etc.—and making gages. For example: From my first purchase of lathes, arbitrary class 16 inch to 20 inch was looked over and the best average nose thread selected for the gage. Now, some of the lathes would be larger and were, therefore, recut to it, but in those which were smaller it was necessary to put in new spindles. Each of these classes was treated in this way. Lately we have been sending these gages to the lathe builders when we order lathes. The advantages of this are too patent to need explanation, as all chucks, faceplates, etc., can be exchanged. Even in the matter of fitting new chucks the item of saving is noticeable as regards fit as well as time, since we cut the chucks to the gage and not to any lathe. Did you ever watch a good "practical machinist" fitting a new chuck back to his lathe by the old method?

Further, each lathe (excepting the smallest) has hubs or "masters" fitted with the smaller sizes of nose threads, all made to the gages. This makes the system universal, for each lathe will take all chucks of its own class, and also all chucks of smaller lathes. The sizes of these threads are not given because they are not all the sizes we would recommend. But they are practically perfect for our own work, since the advantage is primarily in the system and not in the exact diameters and pitches. We have not been so successful in changing between lathes and milling machines, as we must still make bushes and hubs to effect this class of transferring. My opinion after over forty years' experience is that all lathes and milling machines should be standard bolt threads, the length of thread to be one diameter in all cases. This would give a coarser pitch than is usual, but would be all the better for that, as chucks are less likely to seize with a coarse pitch. By this method work could be transferred, chuck and all in one piece, between lathes and milling machines. Some sizes we can now take through three machines—lathe, milling machine and gear cutter, without letting go hold. Another advantage in bolt threads is that taps can be bought in the market for sizing chuck backs. Similar remarks apply to diameter and taper of center tails. It might be well to point out that we hold all drills, reamers and facing tools in a similar manner—any lathe taking in both live and dead heads, all tools of its size and all smaller ones. The general method is that the greater includes the less.

Speaking of the existing confusion in spindle noses—lead screws and change gears are just as bad. Some time ago I asked a lathe builder in the presence of two listeners why he made a lathe for *general* use with a six-thread leading screw and the change gears in steps of four teeth, and offered a dinner for the four persons present if he would tell me. He looked a little bewildered for a short time and answered openly: "I'll be d—d if I know." This answer might be given in many instances, quite correctly, by tool builders.

JAMES ARTHUR,
President Arthur Co.

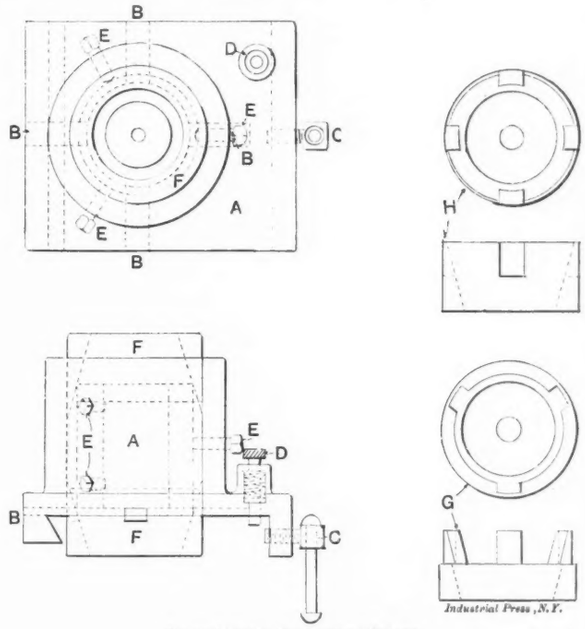
New York.

SOMETHING MORE REGARDING IDLE MACHINES—A TAPER ROUGHING REAMER —TIME-SAVING CHUCKS.

Editor MACHINERY:

In the March number of MACHINERY, I find some remarks referring to the time a machine is idle while the man is working, and I should like very much to say a few words on that subject myself.

The average workman knows a lot of ways to find something to do that requires stopping his machine, and he is inventing new ones all the time. For instance, there is a man turning down a shaft to fit a hole. He knows the shaft is one quarter inch large, but instead of starting a roughing cut he must first



Jig and Tools for Boring Pinions.

get the exact size of the hole—which he probably loses before he gets to the finishing cut—and then has to stop his lathe while he goes after it the second time. Probably the shaft in another part fits into another sized hole. If it does, this chap, unless he has an inspiration, will never think of taking a second pair of calipers and getting both measurements at once.

There are several other members in his family. There is the chap who never grinds a tool until he wants to use it, the one whose oil can is oftener empty than not, and who borrows his neighbor's because he can't stop just now; the fellow whose machine is littered up with a lot of junk, including a choice assortment of old bolts that require two wrenches to operate,

A. MERTES was born in Allegheny, Pa., February 22, 1863. He served an apprenticeship with the Pittsburg Locomotive Works, and shortly after completing his apprenticeship he started the A. Mertes Mfg. Co. (now the Union Foundry & Machine Co.) for the manufacture of gears. For the last four years he has been with the National Gear & Foundry Co. Among other positions Mr. Mertes has held that of superintendent of shops; his specialty is designing special machinery and tools.

and last, but not least, the individual who doesn't bother about how he is going to do the new job the foreman has left at his machine. Time enough to think about that when his present job is done. Besides he is not paid for thinking. He *works* for his wages.

There is a great deal of work in which the time consumed in chucking is a large item, not infrequently requiring more time than the machining, and it is in such cases that the ingenuity of the man counts. If the job becomes frequent, special facilities for handling will be provided and one of the fellows we have been talking about can do it then.

I have lately noticed an advertisement of a small plain plate provided with T slots by means of which a piece of work may be bolted to the plate and the plate secured in the machine. During the time of machining the workman can secure another blank to a second plate, and it is ready to go on the machine as soon as the first is finished, and this method of working can sometimes be used to great advantage on multiple machines.

Some years ago the writer built a machine for boring bronze spur pinions. It had six vertical spindles, three on either side, and below each set of spindles a table with an independent vertical movement. Upon these tables were placed the chucks for holding the work to be operated on. The chucks were all of the same pattern and were secured to the table in one direction by clamping against a slide and located in the other direction by a spring dowel. Being interchangeable any one of them could be used on either side of the machine and under any spindle.

Referring to the cut, *A* is the body casting which after being planed and fitted with the locking screw and spring dowel was bored on the machine by one of the spindles. The chuck was then placed central under the remaining five spindles and the holes for the dowel pin *D* located. The five holes for setscrews *E* were drilled and tapped and the four pieces of machine steel *B* fitted and fastened in place. The rings *F* shown in position were used only to center the blank and, after the setscrews were tightened, were removed. They were first made plain but as trouble was experienced on account of the blanks not being round, they were afterward cut away to give three bearing points as shown at *G*. At first they were made as shown at *H* and cut out on the thin edge to allow them to pass the four pieces *B* and the two upper setscrews.

In handling the work the first operation was roughing with the No. 1 spindles. Two castings were operated on, one on either side. While this rough boring was being done the operator chucked two other castings, using two more chucks. The first two chucks were then moved under No. 2 spindles and those just chucked went under No. 1, for roughing. The No. 3 spindles were for the finishing cut. After the finishing operation the chuck was removed from the machine and taken to a small bench where the chucking was done, the finished piece taken out and another blank chuck ready to go to No. 1. In this way the machine was running nearly all the time, yet the man had ample time to chuck the blanks and change the chucks from one position to another.

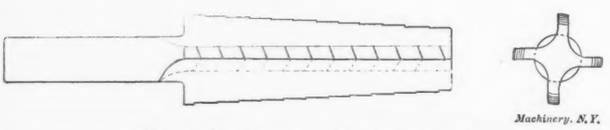


Fig. 2. Taper Reamer with Stepped Teeth.

Eventually the bronze pinions were discarded and steel forged ones used instead. This required drilling the hole from the solid. In one case, the hole, about 1⅞ inch diameter at the smaller end had a taper of 1¼ inch per foot. Here was something not provided for, but by doubling the speed of No. 1 spindle, and using a one-inch drill for the initial hole, enlarging it to 1 13-16 inch on No. 2 spindle, rough reaming the taper on No. 3, and doing the finishing reaming on a drill press, it went through very nicely.

Not having had any previous experience with such a problem, I considered quite a while, and finally decided to make the roughing reamer with stepped teeth. I chased a triple thread of 1½-inch lead, setting the tool so that the tops of the thread were parallel to the axis of the reamer as shown in Fig. 2, whereby the cutting was all done at the corners of the teeth. This reamer was a surprise to all who saw it in operation, it required so little power to drive it. After the roughing reaming was done the chuck was taken to a drill press which held a finishing reamer with a depth gage. The chuck was here set on a spherical seat which was mounted on a compound slide. This was done to allow the work to align itself easily, which it readily did.

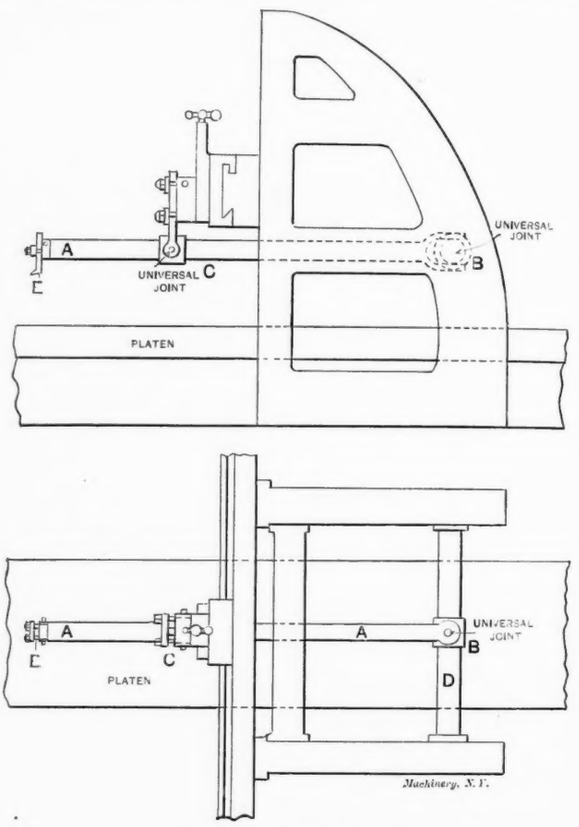
The time required to chuck a piece was about one minute and the drill passed through the blanks in from five to six minutes. The reaming required about two minutes.

Emsworth, Pa. A. MERTES.

PLANER BAR WITH STIFF SUPPORT.

Editor MACHINERY:

A troublesome job on the planer is that in which it is necessary to use an advance tool, as when planing into a cavity, taking short cuts on work wider than the housings, or cutting a keyway in a hub. The latter, of course, is a job that should not be done on the planer, but it often is done, especially on heavy work such as the hubs of large propellers, etc. When we consider the trouble and vexation caused by such jobs—nursing them to prevent the tool digging in and spoiling the



Planer Bar with Stiff Support.

work or breaking the machine—it seems strange that something better than the conventional tool with no other support than the cross-rail of the planer is not more generally used.

The accompanying cut shows a side elevation and plan of a planer equipped with a planer bar or advance tool that is of old design, it having been introduced to the public some thirty or forty years ago. For some reason it seems never to have become generally known, perhaps because it was originally covered with a patent. The patent has now expired so that the public is free to use it without paying royalty. The planer bar, *A*, is forked at its rear end where it pivots on a sleeve, *B*, which is free to turn on the cross support, *D*. This latter is made of heavy section and is firmly secured to the sides of the uprights. The bar is also supported from the cross-rail by a universal joint, *C*, but this need not be of the form indicated in the cut; a ring formed from round bar stock to closely fit the planer bar and provided with a shank to clamp in the toolholder, will usually allow for the necessary vertical and transverse movements. The ring must, of course, fit the bar closely,

but if forged from a round bar it will permit considerable movement while fitting closely enough. If the bar is large enough a clapper-box can be fitted on the end for the tool, *E*. The regular feed movement is used with no change save that it is necessary to use a somewhat finer feed than usual because the movement of the tool *E* is multiplied, the factor depending upon the relative lengths of *EC* and *CB*. It will be observed that the thrust on the tool due to the cut is transmitted directly through the bar to the uprights, and that there is no twisting or canting effect upon the cross-rail whatever.

Newark, N. J. F. EMERSON.

QUICK-RETURN SHAPER MOTION.

Editor MACHINERY:

The drawings accompanying this article represent an attempt to evolve a shaper motion in which a uniformly rotating crank gives a rectilinear motion of variable length to a shaper ram and in which it is possible to vary the length of stroke by moving an otherwise stationary point of the mechanism. The result attained seems satisfactory and has an added advantage not expected at first, that the ratio of cutting to return stroke is the same for all fractions of full stroke. As is well known the Whitworth and sliding link motion

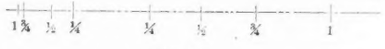


Fig. 3

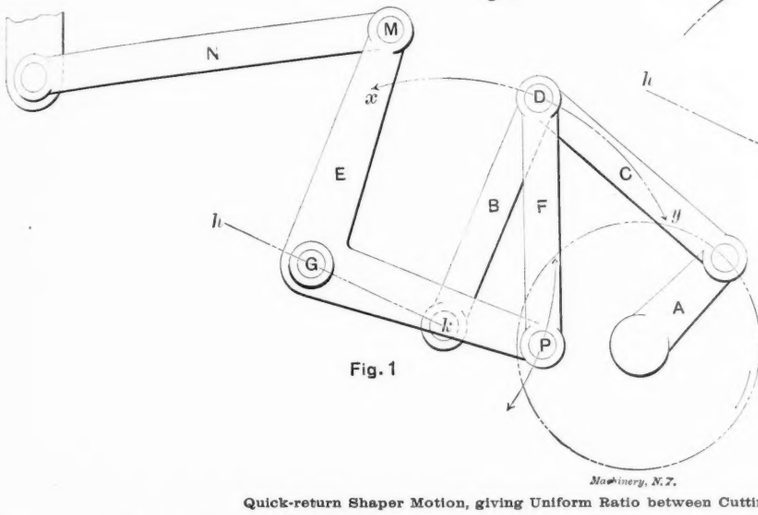


Fig. 1

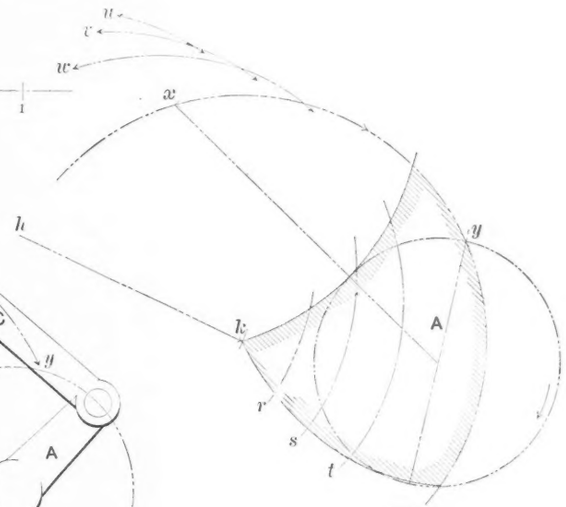


Fig. 2

Machinery, N.Y.

Quick-return Shaper Motion, giving Uniform Ratio between Cutting and Return Strokes.

point *P* for ¼, ½ and ¾ stroke respectively. At the top of the figure arcs *u*, *v* and *w* represent respectively the movement of the point *M* of the rocker for the same fractions of stroke, and on the horizontal line, Fig. 3, is shown the resulting movement of the ram. Its positions at each end of full stroke are shown by the figures 1—1, at ¾ stroke, by figures ¾, ¾, etc. It will be seen that the stroke shortens mostly at one end which, being at the back end of the stroke, we considered rather an advantage than otherwise.

The motion of rocker *B* remains the same at all times and its relative backward and forward motion is transmitted without material change through the succeeding links and cranks, so that the motion of the ram remains in the same ratio no matter how short the stroke. A ratio of 2:1 is as great as can be obtained by the mechanism shown without making the angularity of the connections too great for durability. We did not require a higher ratio but if we had we could have improved on it somewhat by substituting a Whitworth quick-return motion for the simple crank, *A*. In the actual mechanism as planned the connecting-rod *N* was turned in the opposite direction, making the mechanism more compact.

E. H. FISH.

Paxton, Mass.

lose much of the benefit of their quick return as the stroke becomes shorter.

Figs. 1 and 2 appended illustrate the mechanism and its movements. In the two figures like elements are lettered alike. Crank *A* swings through the full circle shown by the dot-and-dash line in the direction of the arrow. Rocker *B* swings through arc *x y* on a fixed center, *k*. It is connected to crank *A* by link *C*. The relative position of the crank and rocker and their lengths are so taken that rocker *B* completes its swing from right to left in one-half the time required for its swing in the opposite direction. Bellcrank *E* rocks on pivot *G*. This point is movable and can be clamped anywhere along line *h k*. This line *h k* in the actual machine takes the form of a slot in the side of the column.

In Fig. 1 bellcrank *E* is set at half stroke. It is given motion from the end, *D*, of rocker *B*, connected to its end, *P*, by link, *F*. It will be seen that if pivot *G*, of rocker, *E*, is set at *h*, that end, *P*, will lie over *k*, and the link, *F*, will simply vibrate back and forth coincident with rocker, *B*, and the bellcrank will have no motion or will be in the position of zero stroke. If *G* is set at *k* then point *M* of the rocker will vibrate back and forth the same as the point *D* of rocker *B*, making a full stroke.

In Fig. 2 the area between the shaded arcs shows that covered by point *P* of the rocker at all positions between zero and full stroke. Arcs *r*, *s* and *t* represent the movement of

THE IMPORTANCE OF LEVELING MACHINE TOOLS.

Editor MACHINERY:

When a man is selling lathes, and knows that they are good lathes, and then time and again has some of them roundly "cussed" because they "will not turn true," when the fact is that there is a "wind" in the bed, he soon arrives at a comprehension of the extent to which the need for correct initial setting of machines and for the preservation of this level condition is unknown or ignored. Incidentally, he studies the subject and learns considerable that before he had not even suspected to be true, and realizes the real importance of the matter.

Such is the situation with the writer, and it seems to him that the good of the trade generally and fair play for the builders of good machines, demands that the subject be given careful attention by every machine operator and owner. I speak of lathes because it is with them that I have had the most to do in this respect, and they are also probably the tools most susceptible of distortion.

At the works the parts of machines are made to fit when everything is perfectly square. If a lathe is twisted in the bed it cannot do true work. The ways, then, will not be straight and flat and the carriage in accommodating itself to their "crowns" or "dips" will give the tool point an erratic movement, and the turning will be correspondingly erratic.

Then, the tail center will be out of line, and altogether there is no telling what shape the work will take. So much for accuracy.

Possibly in these days of rapid work the question of accuracy will average up of secondary importance when compared with durability. Now, consider the increased *wear* that must result, when the ways are not straight. Then the carriage instead of bearing practically its entire length, really does so only in a few spots, and metal is rubbed off at an immensely accelerated rate. This condition will be present in a less degree at every bearing, for the strain in the bed will be communicated throughout the entire machine. The headstock will get some of it and the spindle will tend to bind in its boxes; some of the gears will not line up as nicely as they otherwise would, etc. As a consequence the tool must become worn out and decrepit long before it legitimately should.

A lathe after being run for a time while twisted will become incapable of doing accurate work, even if straightened. When under strain any metal will spring. The question is not whether it will spring but *how much* it will spring, and no matter how heavy a lathe bed may be and how well proportioned, it will "give" enough to make trouble on particular work if it does not stand just as it did when on the testing plate at the works; and because a lathe is of comparatively small size it does not follow that it will work well on three legs, so to speak.

None but a high grade level should be used. A fraction of a thousandth of an inch is the standard in fitting first-class lathes and very little "wind" in the bed will be required to cause an error of a thousandth. A "wind" of 1-16 inch in a short lathe will completely incapacitate it for fine work and yet none but a pretty good level will indicate such an error with any certainty. Surely a wooden carpenter's level will not and a short machinist's level is about as useless. A sixteen- or eighteen-inch one on the order of Starrett's No. 95 will answer very well and as the cost is only two or three dollars it would seem that the tool room of every shop should contain one. The line should split the bubble *exactly*.

The ideal location for tools is on the ground floor, of course. Vibration is bound to be present on upper floors and this and the settling of the building increases the difficulty of keeping the machines in proper shape; and in fact there are many shops whose floors are so unstable that it would be impossible to maintain a machine level in them. Yet the writer has been read the "riot act" because a lathe turned out a few thousandths under just such circumstances.

Now, give the machines and the man who sells them a "fair show." If a lathe built by a responsible concern will not do good work it is pretty safe to assume that there is or has been something wrong with the conditions, so don't insist on a new one without first investigating minutely. Have a good foundation, if possible, and if you cannot have such, do not expect too much of any lathe.

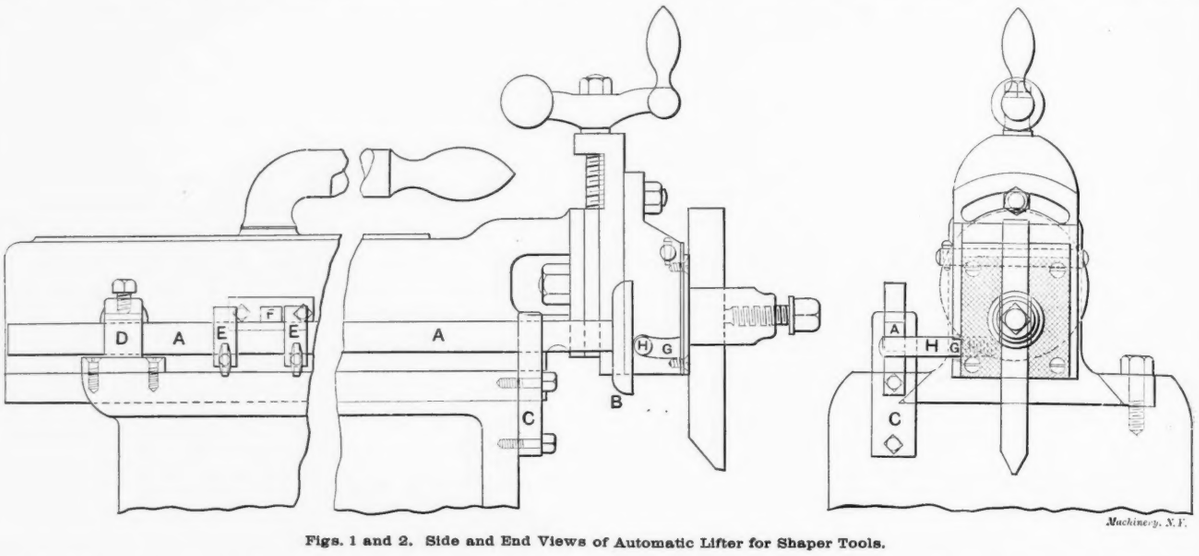
It is certainly exasperating to be forced to pocket the loss for sending a representative to look into a complaint, when nothing is wrong but this eternal leveling, and I hope that this expression may serve in a modest way to promote a better understanding between the two parties in tool deals.

"SELLEM."

DEVICE FOR PREVENTING WEAR OF SHAPER TOOLS.

Editor MACHINERY:

As our whole trade of late years is paying a great deal of attention to the small devices which save time, produce more or better work, or even make the machine operator's task easier or lighter, I will briefly describe an attachment which we made for a Gould & Eberhardt shaper about two years ago to lift the tool during the return stroke, which I consider to be superior to anything I have seen or heard of.



Figs. 1 and 2. Side and End Views of Automatic Lifter for Shaper Tools.

Fig. 1 shows the side elevation of the shaper with the attachment connected; Fig. 2 the front end elevation, and Fig. 3 the view from the front at the section of break shown at Fig. 1. This attachment is quite simple, is easily made and is effective. *A* is a 1-inch by 1½-inch cold-rolled steel bar with a piece welded on one end as shown at *B*. A machine steel bearing piece, shown at *C*, is attached to the front end of the shaper body and has a hole in it to allow the bar *A* to pass through freely. The rear bearing *D* is cast gray iron and has a gib faced with leather and held down by a setscrew to produce a slight, even friction on *A*. *EE* are two machine steel blocks fitted to *A* and slotted on the under side as shown in Fig. 3. They are firmly clamped to *A* by the thumb screws. *F* is a machine steel forging bolted to the side of the shaper ram and has an arm or finger which extends over the top of *A* to engage with the blocks *EE*. For cases where it is desired to use this attachment on com-

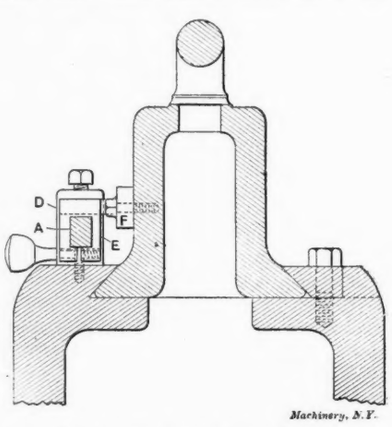


Fig. 3. Cross Section through Lifter.

paratively short stroke with the shaper head well forward, or back, inside the shaper body, we drilled and tapped two more sets of holes in the ram for *F*, as in such extreme cases we had to move *F* either forward or backward to accommodate the job. A slot was milled in the shaper head at *G* to allow a stud *H* which was screwed into the swinging tool block to oscillate.

The drawing Fig. 1 shows the shaper about to start on the forward stroke; during the forward stroke *F* engages with *E* and shoves the bar *A* forward, *B* being just behind *H*. As soon as the ram starts on the back stroke *F* comes back with the ram, leaving *A* and *B* until it engages with the other block *E*, when *A* is carried back with the ram. Of course, when *F* disengages with the forward block *E* at the start on the back stroke *B* comes into contact with *H* and thus raises the tool clear from work. When the back stroke is completed the bar *A* is left by *F* until the shaper ram and swinging tool block are again in the position shown. It will be noticed that the amount that the tool is raised is determined by the distance which *F* must travel between *E* and *E*, and is very easily adjusted to suit the case in hand.

We have used this attachment on a large variety of work, such as dovetailing, facing down with the vertical slide, etc., and find it gives good satisfaction, although it was originally intended only to save the tool from wear on nice finishing cuts on straight work.

A. R. CHERN.

IMPROVED PLUG GAGE CONSTRUCTION.

Editor MACHINERY:

Having been in several large machine shops during the past two or three years, my attention was particularly attracted to the different kind of gages that were being used. First, I wish to call your attention to the fact that I am referring especially to the shops and large manufacturing plants whose articles of manufacture require exact measurements and where gages are used extensively.

Fig. 1.

Referring to the plug and male thread gage, which I am about to discuss, the majority of these shops use the solid gage or in other words, a gage with the gage disk and handle turned from solid stock as shown in Fig. 1. This form of gage gives good satisfaction when a small gage is needed, but where one is required 1½ inch, or over, in diameter, this style becomes very heavy and awkward to handle. It has not only these drawbacks, but also others, such as requiring more high-grade material in its construction; and if the gage disk wears too much, an expensive operation has to be gone through to put it in the right shape.

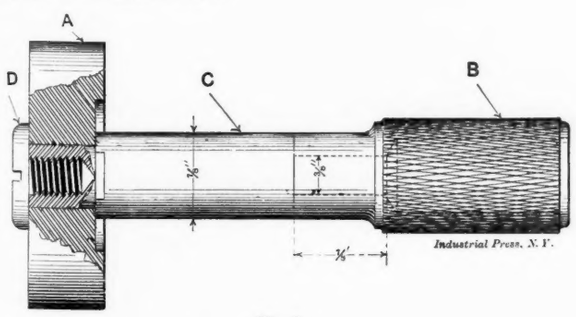


Fig. 2.

The sectional gage shown in the assembled drawing, Fig. 2, is becoming more popular each day, not only on account of its lightness, but also because of its gage disk being transferable when it becomes worn, requiring but a few seconds to make the change provided the disks are kept in stock. The handle is bored out to lighten it, and is knurled, as shown at *B;* it is turned to one or more sizes, according to the requirements of the shop, a quantity being kept in the tool room for future use. I recollect one shop in particular, which keeps four sizes of handles in stock constantly. The fastening screw, *D*, is also made in one or more standard sizes, of which a quantity is also kept in the tool room. The shank *C* is turned to size, according to length, as required.

More or less trouble has been experienced in the past in the use of the sectional gage, especially the male thread gage, on account of the fastening screw becoming loose when the gage gets stuck in the work. I remember one instance, not long ago, where a sectional gage, which depended upon the fastening screw to keep the handle from turning, was being used in

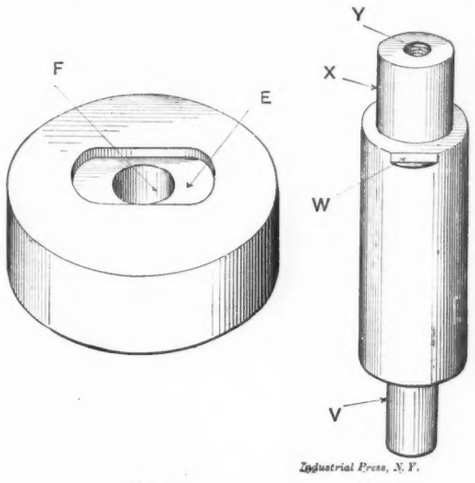


Fig. 3. Fig. 4.

a cylinder, which was threaded on the inside at one end, the other end being blind. This particular gage was being used to test the thread, and when it was run part way through it became fast. As soon as the inspector tried to turn it back, the handle became loose, and then the trouble began. The inspector worked for a half an hour trying to extract it, but without success, after which it was turned over to the toolmaker, who finally extracted it after two-and-one-half hours' work. So you see a gage of this kind would not only be a tantalizer but a very expensive tool in the long run.

The improvement on this class of gage shown in Figs. 3 and 4 avoids all such trouble as I have just described. Referring to Fig. 3, which is the plug or male thread gage disk, as the case may be, the disk may be any diameter, generally 1½ inch or over, and any suitable thickness. It is made of tool steel and hardened, with one side end milled about 1-16 inch deep, *E*, with a diameter ⅛ inch less than the diameter of the shank. The shank, Fig. 4, is flattened on both sides 1-16 inch, which allows it to enter the milled slot in the disk, thereby securing the disk so that it is unable to turn on the shank.

One end of the shank is turned for a drive fit in the handle, while the other end is turned to size to fit the hole *F* in the disk. This end is tapped to receive the fastening screw which holds the shank and disk firmly together. The shoulder at this end is flattened to enter the slot in the disk, as just described.

This construction for gages of this class has been in constant use in one of the largest manufacturing plants in the United States for about two years, and has given satisfaction.

W. E. G.

A SUCCESSFUL APPRENTICE.

Editor MACHINERY:

In the last few months I have noticed several articles about apprentices in various papers and nearly all of them seem to have poor regard for his natural inclinations and habits. Several years ago I had the privilege of working in a shop where an embryo mechanic of the opposite kind came to learn the machinist trade, and with the indulgence of your readers I will try to tell what success he met with.

When Will first came he was placed in the tool-room waiting on the men, operating the saw, and sharpening drills. To me, the first thing that distinguished him from his predecessor was that he was very quiet and had little to say to the men; not shy, but reserved—some of the boys said he was

"stuck up;" next, that he always had the room neat and clean and took much less time to serve the men, consequently was of value to the shop, a thing not likely to be overlooked. He remained in the tool-room about two months, during which time a 14-inch lathe was being remodeled. We had decided to put one of the young apprentices on it turning collars and roughing out stock. When it came to deciding which one the foreman said he believed Will was the best, although pretty new; so he got the chance and his steadiness and ability to learn were very gratifying.

He had this job for about a month when several of the men quit and he was advanced to much more particular lathe work, which he did for about a year with much credit to himself.

Then he asked for and was given erecting work, and naturally the same quality of work was turned out, and after he had been at this for about eight months he got an idea he was worth considerably more money, but he and the superintendent could not come to terms, so he found another job in a small shop as a planer hand, his previous experience on this machine being obtained through observation alone.

When he started learning the trade he had only a grammar school education, but he soon realized that it was not sufficient, so he enrolled in a mechanical course with a correspondence school.

The job he took was evidently not satisfactory for I learned shortly afterward that he was working in a drafting room. In the course of a year I secured a job with the same people and I was very much pleased to find that he was successful and was becoming a very good draftsman. We became intimate friends during the next year and decided to go West together. I got as far as the Rockies and Will went to California.

He worked around in different shops and traveled pretty nearly all over the state, in other words, became a tramp machinist. He finally got a good job as engineer for a mining company and advanced from that to assistant superintendent. He held this job for about a year and then took a job with another company and now, a year later, at about the age of 23 years, he is holding a position at $1,400 per year, while I—well I am making good wages, but I guess Will has more "go-ahead" and ability than most of us. B. A.

THE MAN WHO IS THE "WHOLE THING."

Editor MACHINERY:

While visiting one of the large manufacturing establishments of New England, a few days ago, and talking with one of their prominent men, a fact dawned upon me which I had known before, but which I had never before so fully appreciated. That is, that in the majority of concerns each one has its man who is "the whole thing."

We were speaking of a factory which I had visited the day before, for the first time, and referring to my impressions in regard to the place, I said: "Mr. Jones seems to be quite a prominent man over there." "Oh, yes!" was the reply, "Mr. Jones is the 'whole thing' in that shop."

That is just the phrase I have been looking for through all my mechanical experience and if that man had not said it this would probably never have been written. I have known for a long time that in the majority of shops there is one man who has more to say than all the others put together; this is not as it ought to be. I don't mean that there ought not to be one head to every establishment, because I believe there should be, and that from him all general orders ought to go. But they ought to go through their legitimate channels until the detail is properly carried out, and if orders do not go through their proper channels the detail will *not* be properly attended to.

This "great evil," if I might so call it, exists to a very great degree in our manufacturing establishments to-day. I do not know whether or not it is of recent birth, or whether it is growing or dying (the latter, I hope.)

The man of whom we are speaking is usually very busy. Sometimes he is a man who works very hard, is of humble mind, and honestly wonders how the work would go on without him. He does not know how to divide the responsibility of the shop so that he would be the real head, and yet have others decide the more unimportant matters for him. A man once told me about a machine he had designed, and built for drilling a large number of holes in a piece of wood at the same time. He said it had been in operation in the shop for more than a year, and that a boy could run it, but that he (the designer) had to grind all the drills himself, and as he was foreman of the shop, he had to hustle to look after his work, grind the drills for the machine, and attend to the other duties which only he could do. I suggested that he teach the boy who ran the machine to grind the drills; he replied that he did not believe the boy could do it right. A few months later he told me that the boy was grinding the drills and was doing it just as well as *he* could.

Then there is the man who is the "whole thing" and who delights in it. He likes to handle every matter so that at any moment he can come forth, and give an order to do it this or that way, regardless of all previous orders. This is the most dangerous man of all the list. Most dangerous to the welfare of the business, and most dangerous to the dignity and efficiency of those in charge under him. He gets his subordinates after a while, so that they are afraid to express an opinion in regard to the work, unless they can say: "This is the way *he* wants it." That word "*he*" is the most despicable (to my mind) of all those used by men who are looking after work. It does not make any difference to the man who works for me how the man above me wants it done. The only thing that concerns him is as to how I want it done. And if he does it according to my instructions his responsibility is ended.

I was shown through a factory not long ago by a man who was called the assistant superintendent, but that was not his real position. His real position (if you will permit the genuine truth) was errand boy, or since he was a full grown man "errand man." I do not wish to reflect discredit upon the man in question; the trouble was with the man who hired him, and for whom he worked. I do not know what his motive was, if indeed there was a motive in having his so-called assistant so helpless. Perhaps he might say he was not qualified to take any responsibility. Well, if he was not, why did he keep him? When speaking of the various fixtures, and methods in use in the factory this superintendent would say: "This is how 'he' likes to have them made," or, "I don't just know what his idea was in making it this way, but I guess it is all right." And on another occasion: "Mr. Jones is a great believer in this method of doing a certain thing, and I don't know but I am almost convinced myself that it is the best way, ha, ha, ha."

Now, I like to have my employer tell me what he wants and then give me a clear field to think the matter out. Then I can go at it with a will, take an interest, and bring the work out much more satisfactorily than if he should limit my horizon with detailed instructions which are unnecessary. I like to give a man a piece of work and tell him to do it right, and quick, and that he will not hear from me until the job is done, unless he asks for help or instructions.

A common expression among employees of a man who is the "whole thing" around his plant, is: "Come and look at it for yourself." I have known his foreman a number of times to send a man up to him after completing a piece of work and ask him to come down and look it over. The foreman knew very well that his judgment on the matter was likely to be overruled. So far as I can see, in all cases the man who is the "whole thing" is to blame.

To show the general helplessness of the errand man, caused by the man who is the "whole thing" I will cite a case which came under my observation while a very small boy. A contractor and builder sent a man in charge of a number of carpenters to remodel an old building, with instructions to put in new whatever parts of the building ought to be made new. Now the rub came in in the clause "ought to be made new." The man knew right well that his judgment was more liable not to be accepted than otherwise, and that when the man who was the "whole thing" came, there would most likely be a change of plans. So he was careful not to do much real work until he came around and, in his endeavor to get his employer's mind on all points, as they approached the build-

ing he looked up and said. "Is that post sound?" "What post?" asked his employer. "That rotten one(!)" was the earnest reply. C. M. C.

SOME LATHE FEATURES.

Editor MACHINERY:

The heavy cuts that have been attempted recently have developed a number of weak points of the lathe. In the first place many lathes chatter excessively on large diameters; this is invariably caused by the fact that the carriage overhangs the bed. The thrust *P*, Fig. 1, of the tool, tends to bend the carriage down on the outside. This can readily be seen on many lathes while the machine is taking a heavy cut on a large diameter and especially when the cut runs over slots. The movement of the carriage up and down is quite perceptible. Fig. 1 represents a construction commonly seen on lathes. The apron *A* is held to the carriage by small bolts

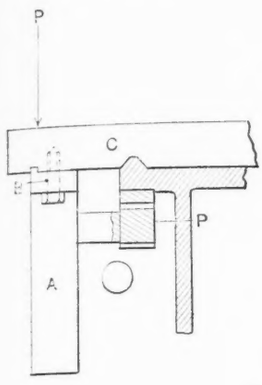


Fig. 1.

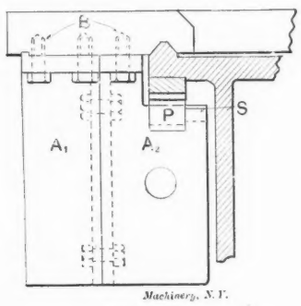


Fig. 2.

B, which upon investigation will be found to be too light. There is a very severe thrust brought upon this carriage when the pinion is pushing the carriage along the rack, against the heavy cut, and the thrust of the pinion *P* against the rack tends to twist the apron out of place. It will also be seen on these lathes that the pinion *P* overhangs the support. In a number of cases, the pinion shafts have become bent and the aprons have been broken. This is not likely to occur on small toolroom lathes, but on 36-inch lathes and above, these things have happened.

Fig. 2 represents a construction of the apron which embodies a number of good points. In the first place the apron is supported by a sufficient number of bolts *B*, and the apron itself is arranged in two parts, A_1 and A_2. The latter extends around the leadscrew and forms a support *S* for the pinion *P*.

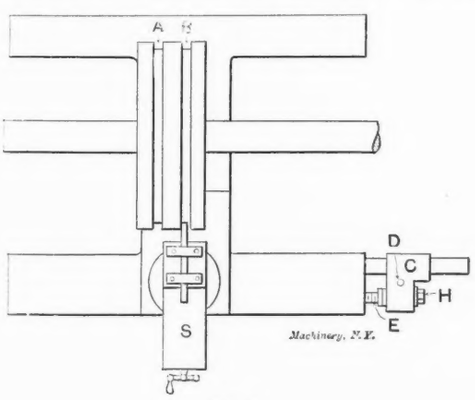


Fig. 3.

This prevents the pinion from bending over on the end. At the same time there are a number of other shafts extending through the apron which are thus supported on each end.

On large lathes the weight of the carriage and the accessories belonging to it are considerable. To move this carriage along the ways by hand requires considerable energy even though the gear ratio from the handwheel to the rack is high. One prominent lathe builder employs a ratchet lever in connection with the handwheel; we thus employ a much longer lever arm and consequently get a more even movement of the carriage with, of course, a proportionately less amount of exertion.

It frequently happens that the lathe hand is obliged to move the carriage along the ways in order to get the proper width for grooves, etc. Fig. 3 represents a piece of work of this

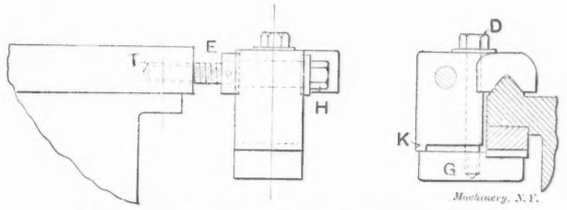


Fig. 4. Fine Adjustment Device for Lathe Carriages.

character. The grooves *A* and *B* must be of a definite width and must be located to suit given dimensions from each other and from the edge of the piston. It is not an easy matter to move the heavy carriage along the ways in order to obtain these exact dimensions; we will either get too little or too much as the carriage moves along the ways by jerks. Since the swivel head *S* must be used as shown, the only method is to move the whole carriage. The lathe hand, having experienced difficulty in getting the tool located properly, will invariably get it approximately right and then pound the carriage back and forth, as the case may require, with a soft hammer; and if a soft hammer is not at hand, it will be bumped with a bar or hand hammer, which cannot help but mar the carriage.

The arrangement illustrated at *C* Fig. 3 can be put on all new lathes and on a great many old ones. *C* is arranged in the form of a clamp and by means of a bolt *D* it can be fixed in any position. *E* is an adjusting screw which has a hexa-

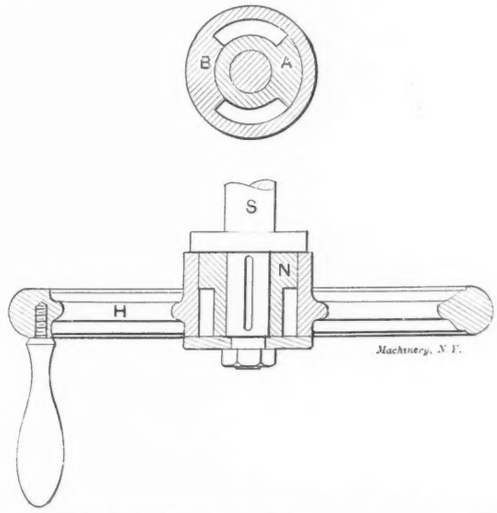


Fig. 5. Handwheel Construction for Easily Loosening Friction Clutch.

gonal head *H* as indicated, and it can be made to fit the standard tool clamp wrench. By means of this screw the carriage can be adjusted to almost any degree of fineness, The head of the bolt *D* can be made to fit the same wrench; a quarter turn one way or the other will either lock or loose the clamp. When the clamp is loose it slides back and forth on the ways with the carriage. A detail of this clamp is shown in Fig. 4. The adjusting screw *E* has a long tap *T* into the carriage. The clamp bolt *D* extends through the clamp proper and is threaded into the gib *G*, which in turn clamps against the under side of the rack. The clamp should be cut away except the small portion *K* in order to give a better clamping effect.

In locking and unlocking the friction from the cross-feed and traverse, in the apron, difficulty is sometimes experienced. In taking cuts the friction must be clamped so tight, in order to keep it from slipping, that it is necessary to hammer the friction in. Of course, when the tool is rapidly digging into

some portion of the work, it cannot readily be knocked out, and a spoiled job is apt to be the result.

In Fig. 5 is shown an arrangement for knocking in and knocking out the friction. *S* is the friction shaft, *N* is a nut, while *H* is the handwheel. The nut *N* has a lug *A* extending outward on one side as shown. The hub of the handwheel *H* has a hub *B* extending inward on one side as shown. It is possible to turn the handwheel through half a turn before the two lugs *A* and *B* come in contact. Once the handwheel is turned so that the hub *B* bumps against *A* any further movement of the handwheel in the same direction will turn the friction shaft *S*. When the friction cannot be drawn tight enough, it can be hammered into place by moving the handwheel back and forth and thus knocking the shaft around until the friction ceases to slip. If the friction is thrown in and the tool accidentally digs into the work, we do not need to hunt for a hammer, but just simply throw the handwheel around and as there is some weight in the handwheel, one knock will disengage the friction.

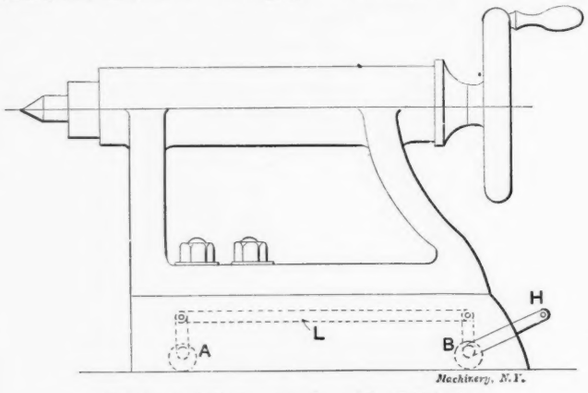


Fig. 6. Anti-friction Attachment for Tailstocks.

As it is difficult to move the carriage along the ways for a considerable distance, it is frequently pulled back and forth by the leadscrew; the tailstock, however, must be pulled along by hand, either by a crank directly connected to a pinion or else by a crank connected to the pinion through intermediate gearing. We can readily obtain any amount of gear ratio and can readily bring the pull at the crank within any desired limit in order to move the tailstock. In gearing this up, however, we lose too much time in moving the tailstock along. A good arrangement is to place a crank directly on the pinion shaft and then place two pairs of eccentric rollers as shown at *A* and *B* in Fig. 6. *H* is the handle which revolves the eccentric and raises the tailstock slightly off the ways. The link *L* connects the eccentric shafts. The lift need not be more than 1-32-inch—just enough to take the weight off the ways. The friction will thus be reduced so that the high gear ratio will not be necessary. The operator can thus readily move the tailstock from a short to a long piece of work and *vice versa* without much fatigue.

FRANK B. KLEINHANS.

CARBORUNDUM WHEELS.

Editor MACHINERY:

Carborundum wheels are cutting material, and not grinding, as usually applied. They are composed of thousands of miniature carborundum chiseis, or cutting tools, hard as diamonds (even cutting diamonds), with keen, sharp, cutting edges, placed promiscuously and in every conceivable position throughout the wheel. Many of these cutting edges are just in the proper position to do excellent work on any kind of metal, or material, usually finished up in this way. Experiments have proven that the coarser the grit the more satisfactorily the work is done, but it is necessary to have the wheel balanced, clean, true and firm on a steady running arbor.

I recently was asked to make some tests on soft steel and cast-iron with a No. 16 grit wheel for a party from Cleveland, O. After making a satisfactorily smooth finish on the soft steel, and before starting on the cast-iron, I touched off the face of the wheel with the diamond. I was asked, "Why do you do that?" I replied, "To insure a true and clean face of my wheel," and was told, "That won't do; the wheel must work on either stock without having to first true it up." While this remark was made by a gentleman who admitted on a previous occasion that he knew little about the use of wheels, it is often only too true that the manufacturers, who should know better, expect too much for nothing. One might, with the same propriety, say there is no use in properly fitting the tools for the various kinds of work, and finish, on the materials worked on the lathe, planer, shaper, drill-press or miller. No good mechanic will even attempt to use a tool on any machine without first preparing the tool for the particular job he intends doing.

Now, it does not follow that a carborundum wheel with its thousands of small cutters (which, when in order, do more and better work than the tools just referred to) should be deprived of the very trivial attention of simply keeping its face clean and true. Rather, were it necessary, give it more attention, since its cutters do so much more and better work. Tools of any kind, however good, must be kept in proper order to do good work.

A 12 or 16-grit carborundum wheel is well adapted for almost any class of work when requirements, as above stated, are complied with, for either roughing down or finishing. Of course, for a fine finish it requires to be run without any feed till the sparks cease to show, and with sufficient water, to prevent the work from heating. All wheels will heat more or less when used without water, and the work will expand and continue to cut away the stock, as it heats more and more, and is liable to be spoiled, especially where accuracy is required.

A wheel that will glaze heats, of course, much quicker than one that will not; much care and attention to the keeping

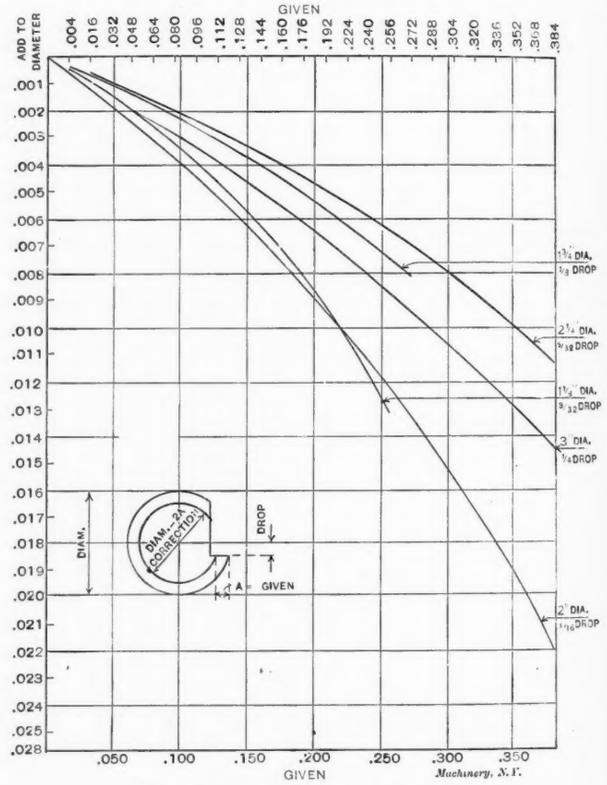


Fig. 1. Chart for Circular Forming Tools.

in order of both wheels and machine must be given. As before stated, arbor and wheel must run true and steady. When you are depending on the small cutters or chisels to make a neat finish they must necessarily run steady, so that the periphery of the wheel does not vary in its travel, otherwise a good finish with a coarse wheel cannot be expected.

Again it must be remembered that there is a difference in finishing work—holding it on the wheel by hand or rigidly holding it between centers, or in a vise or chuck. It would be a hard matter to get a fine finish with a coarse wheel simply by holding it on by hand, as the pressure would be irregular against the cutters. A good finish by hand, how-

ever, is easily obtained by the use of a carborundum buffing wheel of 36 or 40 grit.

I would be glad to hear of the experience of others who are using carborundum as cutting tools. EZRA F. LANDIS.

La Salle, N. Y.

CHARTS FOR FORMING TOOLS.

Editor MACHINERY:

I have read with much interest the article "Straight and Circular Forming Tools," by Mr. J. M. Stabel, as found in the June, 1904, issue. As it falls to my lot to design tools of this character, I have a suggestion or two to make on the tables that he has had appended.

Table No. 3 is gotten up very well; we have a wide range in diameters to select from, with various depths of cutting faces below the center, etc., but unfortunately the value of this table is limited. First, let us glance at Table No. 1. Here we can find the correction for any distance for *a c*, up to ½-inch varying by 0.001 inch. For an odd figure the method of arriving at the correction by means of adding the constants, is not really first-class, as there is that element of danger of an error in the adding operation. Let us now refer to Table No. 3. It is just as necessary to have the correction known, for distance *B C*, varying by 0.001 inch as in Table No. 1, but this table is calculated for *B C*, being either 1-16, ⅛ or ¼ inch, and you may make dozens of forming tools and not have use for the table.

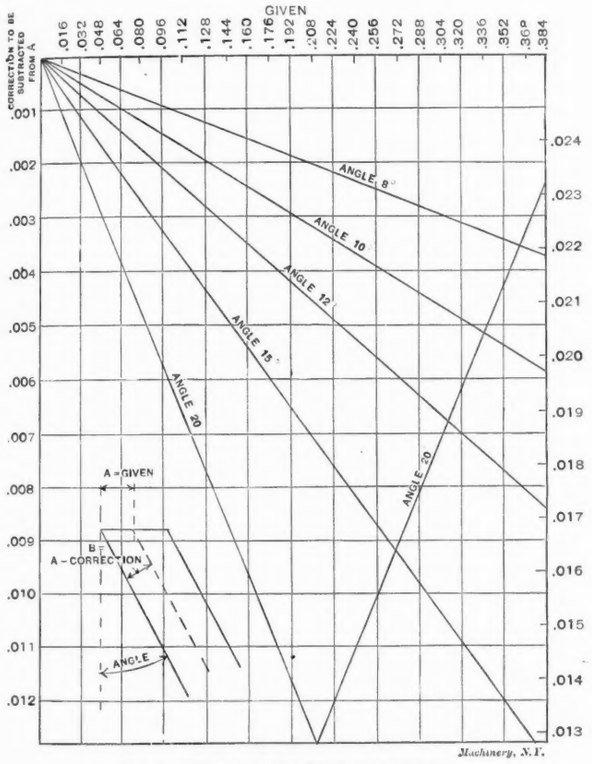


Fig. 2. Chart for Straight Forming Tools.

Accompanying are two charts that I have designed; the various curves and lines thereon are made from what I know to be generally used. I will give an illustration of their use as the best way to explain them. Referring to Chart No. 1, the distance *A* (see sketch) thereon is calculated from whatever the piece is, we have to make. Under the word "Given," at the top and bottom of the chart, locate *A*, and follow down (or up) the vertical line until it intersects the proper curve. This point carried to the right by the horizontal line, will indicate the correction to be added to the diameter, after subtraction 2*A*, of course. The horizontal divisions for the verticals vary by 0.004 inch, and the corrections read to 0.0005 inch, which for practical use is as near as required.

The same illustration will answer for Chart No. 2; in this the correction is carried around to the right of chart.

The Chart No. 1 shows only five curves and there is no question but what there are many other standards, so it is quite impossible to make a complete chart or table. This one covers the range of my experience in automatic and hand screw machines. For instance I use a circular tool 2¼ inches diameter and 5-32-inch drop as much as any other; on straight tools I generally use angles of 8 and 12 degrees, seldom 10 or 15 and never 20 degrees. Unless we know all standards, I think it best to avoid useless calculations.

GEO. D. HAYDEN.

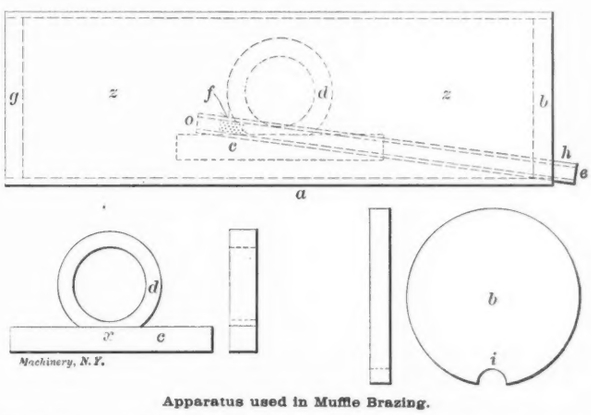
New Bedford, Mass.

MUFFLE BRAZING.

Editor MACHINERY:

Oftentimes in model and experimental work it is cheaper, and better in most cases, to braze two pieces like *c* and *d* together at *x*, than to make the shape out of solid stock.

I made a pot *a* of suitable length out of iron pipe, and had the bottom *g* welded in, to make it air-tight, as all air must be excluded to make the job a success. Then I took a piece of ⅛-inch gas pipe, *h*, cut it off to the right length, and closed the end at *o* with an iron plug. The top of the pipe *h* was



Apparatus used in Muffle Brazing.

filled for a distance of ½ inch with brass filings, *f*. *c* and *d* were firmly secured together with iron wire, and brass filings were placed around the joint at *x*. The job was wound up with cotton cloth and string to keep the charcoal off the work, and was placed in the pot *a* so that *c d* and *h* would come central in *a*. *h* was placed on a slight incline, as shown. The remaining space in *a* was filled with clean charcoal. The cover, *b*, which is milled out at *i* to allow *h* to pass by it, was put in place and luted with fireclay. The muffle was then placed in a furnace. When the work has attained the proper heat the brass filings *f* will melt and run down the incline in the gas-pipe, *h*, and out at *e*, and in coming in contact with the air will emit the characteristic blue green flame which indicates that the brazing material has reached the liquid state.

The operator should then wait a short time after the brass has flowed to make the job sure, then take the pot out of the furnace and lay it aside to cool. After taking the job from the pot, it will be found to have a perfectly brazed joint, and as clean and bright as a new silver dollar.

New Haven, Conn. A. L. MONRAD.

[The old-time German locksmiths practiced muffle brazing to a considerable extent, but the muffles they used were made of common clay. Suppose a key of complicated shape was to be made. It appears, from what the editor has been told by one of these old-time locksmiths, that the common practice was to build up such a key from bits of iron arranged to form the projections to fit the wards of the lock. These, of course, were filed to shape afterwards, but by the building-up process it appears that considerable labor was saved on account of the simplicity and sureness of the clay muffle brazing process. When the parts of the key were built up, they were firmly bound together with wire, and brass filings were placed around the joints. The whole was then luted with clay, forming a mass considerably larger than the work. This was put into the forge and heated until the brass flowed, which was known by the color of the flame; then the whole mass intact was removed and allowed to cool before breaking apart. The process is said to have been absolutely sure every time, and one easily learned.—EDITOR.]

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A DRAFTING KINK.

Here is an expedient in making scale drawings, which, while very simple, seems new to almost every one I meet. If drawing circles of scales half size or smaller I take the radii off directly from the scale of half the size I am working from. For instance, suppose that a drawing is being made half size and that a circle of 18⅝ inches diameter is to be drawn, I set the compasses to 18⅝ inches on the 3-inches-to-the-foot scale and they are set right without any calculation or chance of mistake. If working with a scale of 1-inch-to-the-foot then I lay off radii on the ½-inch-to-the-foot scale and so on. Compare this with dividing 18⅝ inches by 2, and the saving in time and gray matter will be evident. E. H. FISH.

Paxton, Mass.

SIMPLE BALL REAMER.

To make a fluted ball reamer of the ordinary style requires considerable time with the facilities at hand in most tool rooms and to make it so that it will be accurate a great deal of care must be exercised, but here is one which is inexpensive, easily made, and it will bore an almost perfect ball socket. This style of ball reamer has been used by one of the local firms for years and has always given good satisfaction. A piece of steel is turned to the desired size and a cut-off tool partly forms the disks. The disks are then finished, as in Fig. 1, on the outside, making a slight shoulder on either side and cutting a shallow angular groove around the center. They are then further separated by cutting in with a parting tool again as far as possible without bending the steel, after which

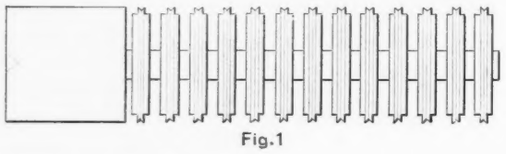


Fig.1

Fig.2

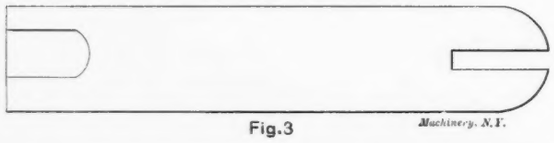


Fig.3

Machinery, N.Y.

the disks are faced off to a uniform thickness and cut apart with a hacksaw. The roughness left by the hacksaw is smoothed off on an emery wheel. Each disk is filed away on one side of the angular groove for nearly one-fourth the circumference, then the alternate side for nearly one-fourth, and so on entirely round the disk, allowing cutting edges to lap a trifle, as in Fig. 2. They are then ready to temper. The cutters are held simply by being driven into the holder, Fig. 3, and are used until dull, when they are given a half turn and fresh cutting edges are presented to the work. With careful usage one cutter will last a long time.

Salem, Ohio. ROY W. HARRIS.

SCREW CUTTING WITH THE FEED GEAR.

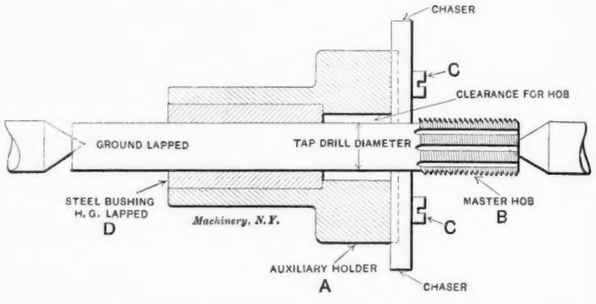
Many articles have been written about screw-cutting, but the following may be new to some of your readers: I was employed at one time in a little mining camp repair shop, the only lathe being 26-inch swing; the finest pitch that it would cut was twelve threads per inch and no provision was made for compounding the gears. One of the first jobs I had was to make a new needle valve for a lubricator, the threaded part being about ¼ inch diameter and 24 threads per inch. I placed two gears of the same size upon the stud and screw and started the feed, the friction being driven through leadscrew. Counting the number of revolutions to 4 inches of travel of carriage I found 80 revolution to 4 inches, or a feed of 20 per inch. Taking that as a base the same as if I had a 20-thread leadscrew, gave the proportion 20:24 = 40:48.

A 40-tooth gear was put upon the stud and a 48-tooth gear on the screw, which gave the desired pitch.

At another time I had to repair a drill grinder chuck; the thread on the spiral or scroll plate had been broken out. The old spiral was faced off and a steel plate was fastened on in which a new spiral thread was to be cut, the pitch being ½ inch double thread. The lathe to be used was a Putnam—one of those in which the driven gear on the stud slid upon a feather that it might be driven either by a gear on the cone or by a gear of the same size on the lathe spindle. The cross-feed was driven through the screw. Two gears of the same size were mounted on the screw and stud and starting feed the revolutions were counted. I found the cross-feed tool block moved 5 inches for 35 revolutions of the lathe spindle, or equal to 7 threads per inch. Using this for a base the same as if I had been using a 7-thread leadscrew gave the proportion 7:2 = 70:20. Having those gears I used a 700-tooth gear on the stud and a 20-tooth gear on the screw, and thus gained the desired result. J. T.

RECUTTING THREAD CHASERS.

For those who are interested the accompanying sketch will show more thoroughly the manner in which thread chasers can be accurately re-cut than would be possible in a briefly worded description. *A* is an auxiliary holder, of machine steel, having slots cut in same to fit chasers, and it also contains a steel bushing, *D*, that is hardened, ground and lapped. The master hob, *B*, is made having a long shank which is ground and lapped to fit the bushing. The diameter of shank



is same as that of tap drill for chaser to be cut. To re-cut chasers remove same from slot in die head proper, and after annealing, the chasers are placed in slot in auxiliary holder and the master hob also is placed in holder, as per sketch. The chasers are now brought to bear against shank of hob and securely tightened by means of screws, *C*. The hob can now be made to cut chasers in same manner as an ordinary tap and the long bearing in bushing *D* insures accurate results. Two hobs should be used, one to remove stock, and one to cut finished sides. It is almost impossible to obtain accurate results if the chasers are cut independently, on account of the difficulty experienced in getting the threads of the different chasers to match up when in place in the die head. The above fixture was designed by the writer for cutting chasers used in self-opening dies and the method is perfectly reliable. FRANK E. SHAILOR.

Great Barrington, Mass.

ANOTHER "HARDENING WORK IN PART."

As Irm J. says of the letter from O. M. B. in regard to hardening work in part, "There is perhaps one shop in fifty that is equipped to turn out work in that way;" and Irm J.'s method would work only on steel that had sufficient carbon in it to cause it to harden. What is the use of going to all that trouble, even if you were fitted to do it?

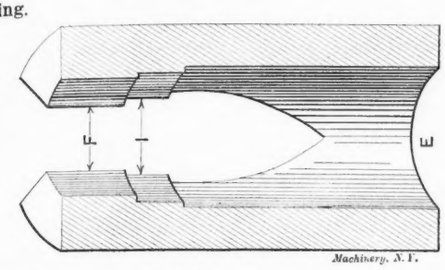
Suppose you have a piece of shafting that you wish to harden where the bearing comes, and do not care for the rest to be hard. Locate the bearing and put that part in the fire and heat it to a cherry red, and put on it some cyanide of potassium and let it run around over the part you wish hardened. Then take the piece from the fire and cool it quickly with water, as you would if it were tool-steel and you wished

to harden it, only in this case you do not need to draw the temper. This way is much easier and any shop that has a forge can do it as well as the best equipped shops. C. H. A.

New London, Conn.

TO PREVENT SPRING DIES CLOSING IN.

I have read Mr. Markham's articles with much pleasure and have received a great deal of benefit from them, and I wish to call his attention to this method of overcoming a troublesome feature of spring dies. Having a great deal to do with this class of dies I find that when hardening them they have a tendency to close in at the top, which makes the die under size; and to overcome this, I use the methods here shown in the sketch, which shows a sectional view before threading.



After having them all finished and ready to temper, I heat the dies to a low heat and drive a piece of punch rod into the portion *I* which is left enough smaller than *E* to make a driving fit. This forces the die outward and just enough to counteract the closing in, so after the die is tempered it comes back to its normal state. We had a great deal of trouble with our dies until this method was used and now we have no trouble at all with them. I have seen a great many dies thrown away on account of their closing in, and where one makes the dies and never gets a chance at tempering them, he hardly ever knows whether they are good or bad, for when a die does not work just right, the men usually throw it away and get a new one. W. VAN ORMAN.

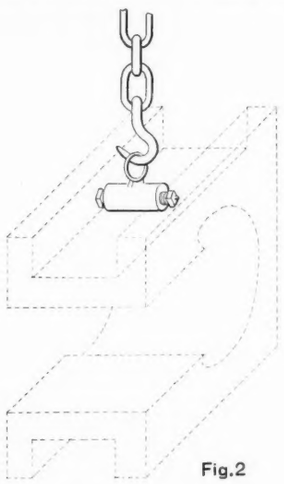


Fig.2

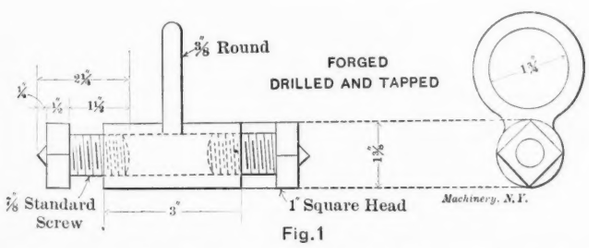


Fig.1

Lorain, Ohio.

DEVICE FOR LIFTING DRIVING BOXES.

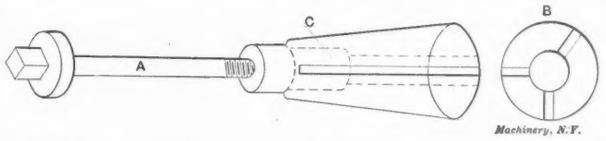
The sketch herewith shows device for lifting driving boxes, and although it is a small device, still it is one of the best shop kinks that I have ever seen in a railroad shop for this purpose. It is something of my own design and has been in use for the past three years, proving very handy for lifting driving boxes on and off machines, and also in fitting driving boxes to driving journals on the erecting side of the shop. By the introduction of a small traveling crane over pit, which is used for fitting the above mentioned boxes, and a small air hoist, an apprentice boy, without the assistance of a helper, can apply a driving box on one of the modern engines without any effort.

Fig. 1 shows the construction of the lifting device, which can be made of wrought iron or steel forging, or a brass casting. By simply drilling a hole through the body, tapping out and inserting two setscrews, the device is completed, and after the setscrews are imbedded into the flanges, it is impossible to pull away. The cost of making this device is very little. Fig. 2 shows the device in operation, and the manner in which it is applied in the driving box. Prior to using this I was compelled to use chains and clamps of different styles and rude construction. I. C. HICKS.

San Bernardino, Cal.

CHUCK FOR HOLDING END MILLS.

I saw in July issue of MACHINERY a description by Mr. Ridderhof of a chuck for holding end mills, which is without doubt a very good tool for the purpose; but I have made and used one for the same purpose, and often wondered at people being satisfied with the old taper shank mills which Mr. Ridderhof justly criticizes. I herewith submit a rough sketch of the one which I prefer to all others I have seen and which, if made accurately from good machinery steel, will remain practically accurate for an indefinite time, if reasonably used. The mills to fit it are cheaply made, being straight shanks that may be ground true after tempering, and they may be allowed to project more or less to suit the work in hand. The chuck body, *B*, may be made any size to suit the hole in the main spindle or the vertical attachment; if for the large hole, chamber out at *C* to allow it to spring and clamp the shank firmly the whole length. Bolt *A* is of any length to suit. L. E. MUNCY.



Syracuse, N. Y.

TURNING SHAFT LONGER THAN CENTER DISTANCE OF LATHE.

Not long ago we had a shaft 4 inches square by 15 feet long that had to be turned to 3 15-16 inches diameter, about 1 foot at one end and 3 feet at the other. The largest lathe in the shop then, would take but 12 feet between centers. I finally planned a way to turn it as follows:

We had a cathead similar to that described by J. J. Dawson in the July number, only that it had four setscrews in each end. By the way, I wish to make a suggestion in regard to such catheads. The ends where the screws go through should be made quite heavy; otherwise in tightening them on the work, the pressure from the screws is liable to spring the cathead out of true, making it slightly oval; and that would likely cause trouble with the steady-rest.

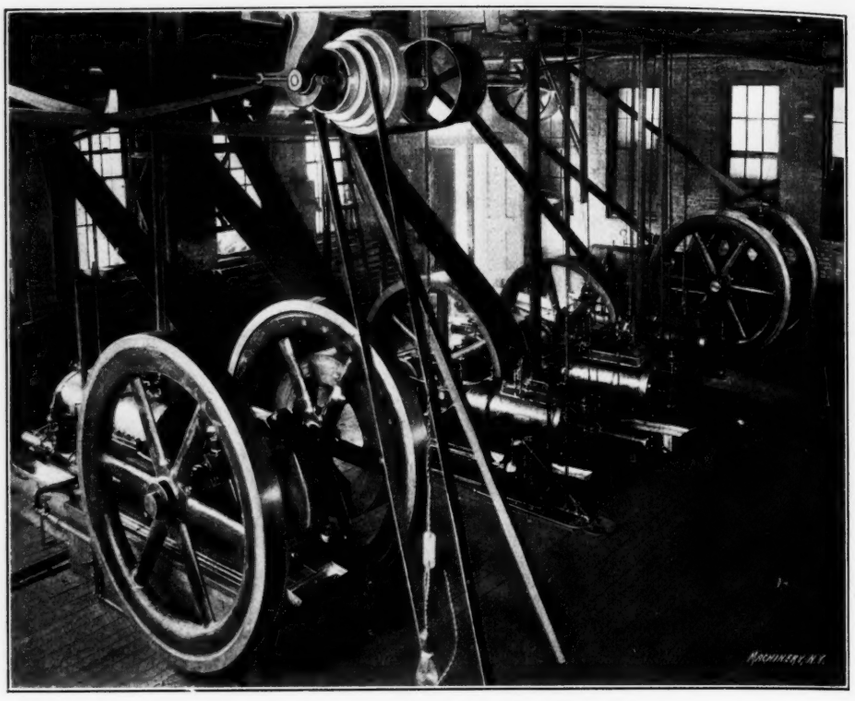
I first took a short piece of shafting that was centered, and slipped the cathead on it, and then put the piece in the lathe on centers. After adjusting the cathead till it ran true, I adjusted the steady-rest to it—which centered the steady-rest. I then removed the cathead, short piece of shaft, and the tailstock from the lathe, and slid the steady-rest down to the other end of the lathe and clamped it there. Slipping the cathead onto the shaft, I hoisted the shaft into the lathe and chucked one end and let the end with the cathead run in the steady-rest. It was then easily trued by the chuck at one end and the cathead screws at the other, and then the end nearest the headstock was turned, after which it was an easy matter to change ends and turn the other end. The shaft had a couple inches in length to spare, and that gave enough to chuck. The ends, of course, were not turned, but were sawed off later, leaving the two ends turned to size, and in line and true. C. H. A.

GAS ENGINE POWER PLANT.

The works of the Star Drilling Machine Company, at Akron, Ohio, are of interest, as it is one of the few large plants operated entirely by gas engines. The power plant consists of four 60 and one 35-horse-power Columbus engines, making a total of 275 horse power. These engines are so distributed throughout the various departments as to reduce the amount of shafting to a minimum. Altogether they constitute a unique installation for so large a manufacturing plant.

One 60-horse-power engine operates the wood-working machinery, another of the same size operates the metal-working department, and the 35-horse-power engine operates the lighting plant. The other two 60-horse-power engines shown in the illustration drive air compressors to operate drop hammers, formerly operated by steam, and all the other pneumatic tools, such as drills, chipping hammers and hoists.

Mr. Miller, superintendent of the Star Drilling Machine Co., states that they find this division of their power very convenient, as they can run any part of the plant without operating the balance, and having no long lines of shafting, the loss by friction is small and the cost of attendance, fuel and supplies much less than with the steam plant which has been abandoned. The gas engines in this plant were installed by the Columbus Machine Company, of Columbus, Ohio.



Gas Engine Power Plant of the Star Drilling Machine Company.

STURTEVANT ECONOMIZER.

As a natural consequence of their mechanical draft apparatus the B. F. Sturtevant Co., Hyde Park, Mass., are to manufacture an economizer. While the economizer is adapted to installations with or without mechanical draft, special attention is given to equipping power plants with the combined apparatus. In order to adapt the economizer to every possible condition it is built up of sections, with pipes staggered to intercept the gases to as great an extent as possible. There is also built what is termed a Pony economizer, designed to give the smaller power plants from 50 to 500 H. P. capacity an apparatus adapted to their needs. The headers supporting the different pipe sections are carried by so-called wall boxes, which are placed in the side wall of the setting, forming a part of the wall. The whole weight of the economizer is carried by these wall boxes and is thus distributed throughout the length of the setting. Practically all the joints are metal to metal, with taper fits, which facilitates making the repairs.

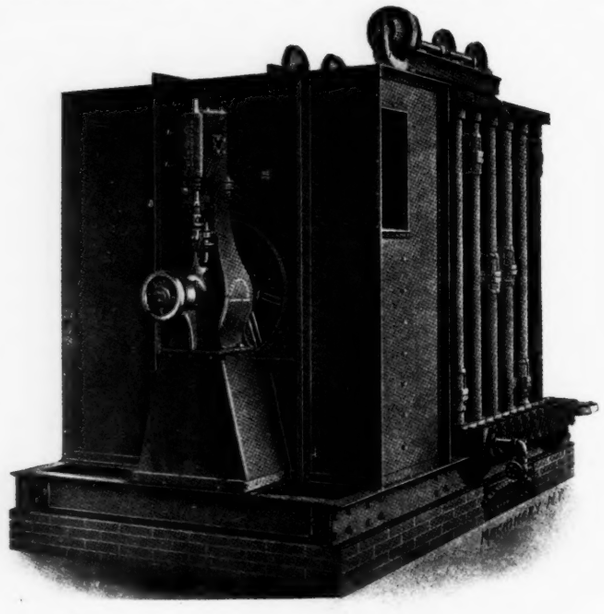


Fig. 1. Sturtevant Economizer.

In Fig. 2 is a diagram showing the process of removing an old tube and inserting a new one. Pipe No. 1 is shown in position, with the inside cap in place at the top. No. 2 is a cross-section of the pipe in position. No. 3 shows the draw-out rods in place to start the pipe from its friction joints. The left-hand rod has a hook which fits under the lower edge

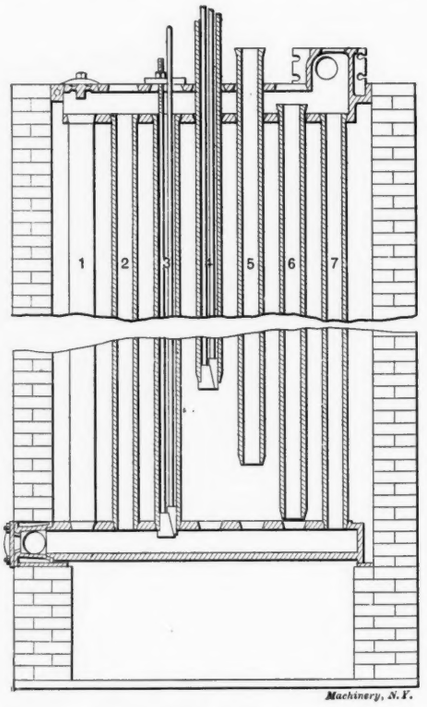


Fig. 2. Diagram showing Method of Replacing Tubes in Sturtevant Economizer.

of the pipe and is wedged in place by the taper end of the right-hand rod. By merely turning the nut at the top the pipe is started from its position. No. 4 shows the pipe removed. Nos. 5 and 6 illustrate the new pipe entering and No. 7 the new pipe in place. By hammering the pipe in slightly the joints become tight. The economizer is fitted with scrapers which automatically travel up and down the pipes. They are operated by an improved form of reversing apparatus.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

8. H. S. has sent us a sketch showing two methods of connecting two shafts, and wishes to know which will prove the more efficient and about what the losses will be in each case. In the first example a gear wheel with 31 teeth drives one with 13 teeth, and on the same shaft with the latter is a sprocket wheel 12 inches in diameter which is connected by a sprocket chain with a wheel 6 inches in diameter on another shaft. In the second example the two shafts are connected by a chain drive without any intermediate gearing. We think it probable from the sketch that the gear wheels have cast instead of cut teeth and that the sprocket chain is of an ordinary type. Under such conditions we should expect the loss to be about the same for a sprocket drive as for a gear drive. Assuming the loss for the gears to be 15 per cent., and for the sprocket drive 15 per cent. also, the total efficiency in the first example would be $.85 \times .85 = .72$. The efficiency of the direct drive in the second example would be about 85 per cent.

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9. S. C. Co.—Will you kindly advise us what is understood by the amount of power conveyed by a "run of stone?" A good many property rights in water power have in the past been conveyed under the description of "so many run of French buhr mill stone and the necessary machinery," and we would like to get the best statement of the amount of power which engineers agree on as being covered by such a term.

A.—We have submitted this question to Mr. Samuel Webber, who, for so many years was identified with mill work and power transmission, so that he is unusually well qualified to supply the information requested. He replies as follows:

I have devoted a great deal of time to this question, and looked up every available authority, from old Nicholson's "Operative Mechanic" down, coming to the conclusion from the older authorities that "one horse power per bushel of grain, ground per hour" was an average rule. This was verified by the results of the test of an automatic engine at the mill of Gibson & Co., at Indianapolis, published in Van Nostrand's magazine for December, 1877. In this article the mill was stated as containing "12 runs of 48" French buhr stones, and the consumption was 7½ to 8 bushels wheat per hour. The power used by indicator cards was: Condensing, 105.4 horse power: non-condensing, 115.4 horse power. This included cleaners, bolts, etc., but in the non-condensing trial the elevators were worked more steadily than in the condensing one. This gives in the non-condensing trials a little less than 10 horse power per run; in the condensing trial a little less than 9 horse power, and deducting engine friction, about 9 and 8 horse power respectively. So that I have called the water power required from 8 to 10 horse power per run, according to the character of the wheel, whether modern turbine or old breast. For the old deeds, when breast wheels or overshots were in use, I usually call it 10 horse power per run.

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10. O. W.—Will you kindly tell me the fusing point of aluminum, and if it can be molded. Also the sand to use for a green sand mold. Will chilling have any effect upon the mold?

A. We submitted this question to the Pittsburg Reduction Co., who reply as follows:

The fusing point of pure aluminum is 1,250 degrees F. Aluminum can be cast in both sand and metal molds as readily as brass, and in general castings can be satisfactorily made by the use of an ordinary sand mold, such as would be used for brass casting. The only additional precaution which is necessary to be taken is that the mold should be thoroughly well ventilated, and also that it should have a large gate and high riser. These points cannot be too strenuously insisted upon. The object of the large gate and high riser is to allow the metal to flow in and supply the shrinkage, as the aluminum in the body of the mold shrinks, and it is very much more necessary to have large risers in the use of sand molds than it is in the use of hot iron molds, where only small gates are necessary. As in other castings, of course, the finer the sand that is used in making the molds the more perfect the surface of the casting. The metal should be poured as cold as possible in order to insure sound castings, free from blow-holes (caused by the very great absorption of gas by overheated molten aluminum), or cracks and depressions due to shrinkage. A good method of producing sound castings in iron molds is to heat the molds to about 1,200 degrees F., or about the temperature of the molten aluminum, and cause the metal to cool from the bottom of the molds upward by a blast of cold air or other suitable means. Thus the metal in the comparatively large sinking head or riser remains molten until the casting is solidified. In this way the impurities segregate in the sinking head and the shrinkage is replaced with fresh additions of molten metal.

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11. C. G. B.—Can you give me information as to the carrying capacity of ball and roller bearings? As far as I can find, this information is not accessible, except such as is given in catalogues of manufacturers where I think the capacity of such bearings is overrated.

A.—In the November (1898) number of MACHINERY Prof. C. H. Benjamin contributed an article upon ball bearings in which he gave results of tests and directions for the design of such bearings. He also has given similar information in his excellent treatise upon machine design, which is published by Charles H. Holmes, Cleveland, O. The carrying capacity of ball bearings is generally calculated as some factor of the strength of the balls. This is not a satisfactory method, but may be as good as we have, with our present knowledge of the subject. The strength of steel balls varies greatly with different grades of steel. Values for breaking strength have been selected from the tables referred to, however, as follows:

For 1¼-inch hardened steel balls, 6,000 pounds per ball; ⅜-inch, 18,000 pounds; ½-inch, 30,000 pounds; ⅝-inch, 42,000 pounds; ¾-inch, 54,000 pounds; 1-inch, 77,000 pounds.

In the Journal of Worcester Polytechnic Institute, Vol. 1899, Alton L. Smith says: The rule of loading balls to 1-5 of their breaking capacity is far from being approximate. If held between two parallel surfaces less than 1-10 of their breaking load would be a nearer approximation for safety. If, however, the ball rolled in V-grooves so as to have four points of contact, a higher load could be carried. The surface resistance of a small ball of ¼ or ½-inch diameter is probably as great as that of a 1-inch ball, in which case it might safely carry the same load as the large one if this were within the elastic limit. The safe load should not be based on the breaking strength but on that load within the elastic limit which will mark its surface, when in contact with a hardened flat plate. In his book on machine design Prof. Benjamin states that ball bearings should not be called upon to sustain nearly as great a load as 1-10 of the breaking strength of the ball, as stated above. He says that experiments he has made show that a ¼-inch ball loses all value as a transmission element, on account of distortion, at any load of more than 100 pounds. He also quotes Prof. Gray, who places this figure at 40 pounds only, for ⅜-inch balls; also see Machine Design, Vol. II., by Prof. F. R. Jones.

We know of no information upon roller bearings, excepting such as was obtained by tests upon the Hyatt roller bearings by a committee from the Franklin Institute. This information can doubtless be secured from the manufacturers of this style of bearings, the Hyatt Roller Bearing Co., Harrison, N. J.

* * *

Pure gold has the unique property of welding at ordinary temperatures. It must, however, be absolutely pure and clean, and must be annealed just previous to using. When in the thin leaf state mere hand pressure is sufficient to get an intimate cohesion, although dentists generally use light percussive tools when using gold for filling teeth.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

SIXTY-INCH ROLL TURNING LATHE.

A 60-inch motor-driven roll turning lathe has been built by the American Tool Works Company, Cincinnati. In view of the severe duty for which the lathe is intended, it is built exceptionally heavy. The lathe is driven by a 25 horse-power variable speed motor, which is mounted on a substantial stand at the rear of the headstock and is connected to the driving shaft in the headstock by silent chain, as shown in Fig. 2. Primary speed variation is obtained electrically, through manipulation of the hand wheel at the right-hand end of carriage, which starts, stops and reverses the machine, and also varies the speed by minute increments. These electrical changes are supplemented by mechanical changes obtained through the all-gear headstock, by means of the two levers shown on the front of the hood. This headstock contains an assemblage of gears oppositely disposed on the upper and lower shafts, engaged and disengaged by throwing the levers to right or left. The proper combination of the levers for any desired speed is indicated by prominently placed index plates. The range of speeds thus obtained through both the headstock and the motor is very wide, varying by minute gradations.

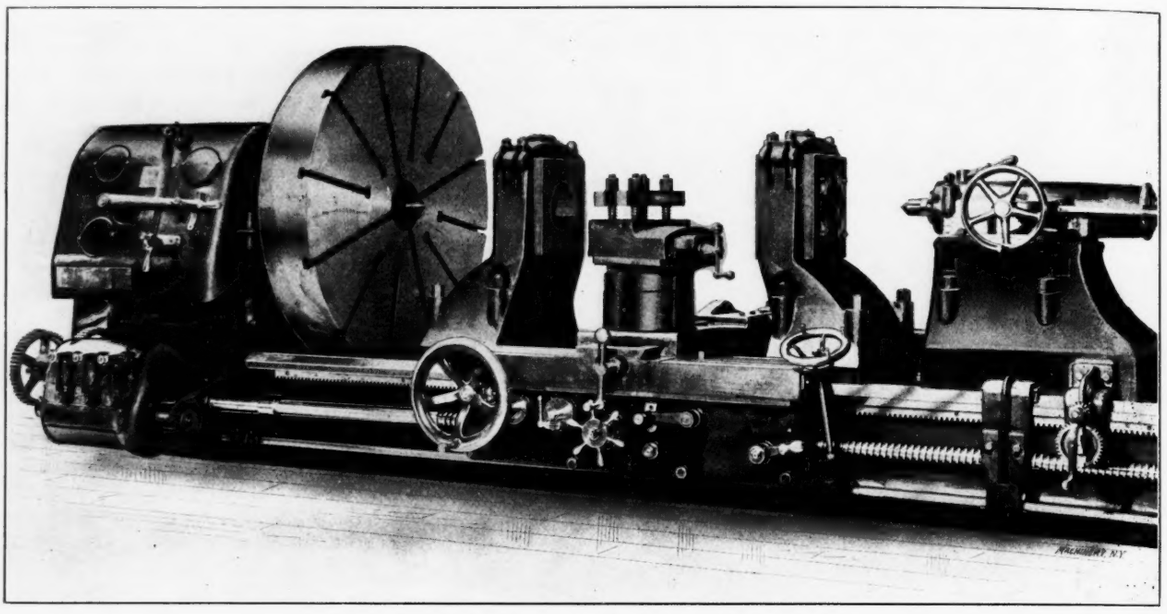


Fig. 1 American Tool Works Company's Sixty-inch Roll Turning Lathe.

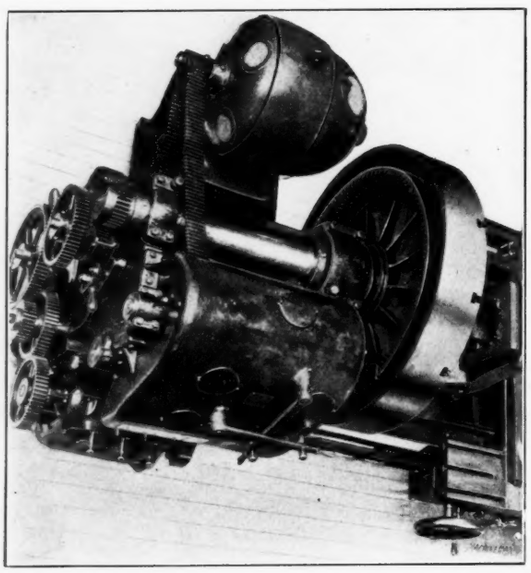


Fig. 2. Upper View of Headstock showing Motor Connection.

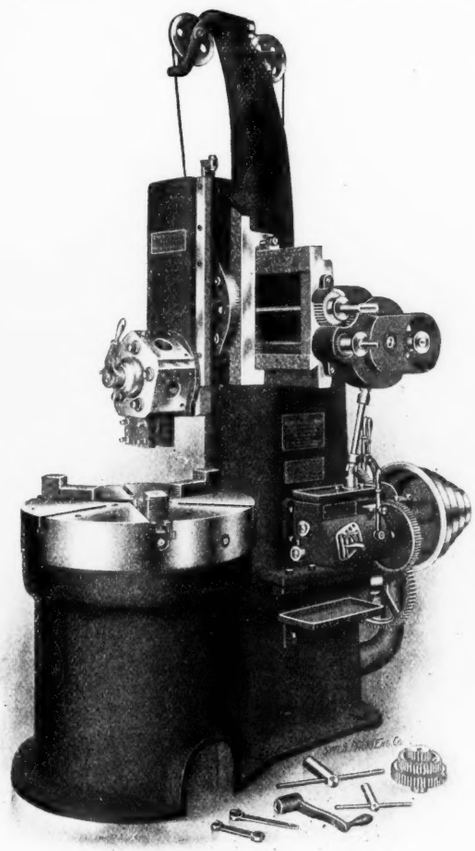
Below the headstock, on the head end of the bed, is located the geared feed changing device. Through the three levers shown at the front of the box, seven positive feeds are obtainable, without removing a single gear. The gears are mounted on two shafts and are completely housed in. Simple index plates show clearly the various combinations for obtaining any desired thread, pitch or feed.

Aside from the motor drive, the features of especial interest on this particular lathe are the roll turning attachments. The heavy housings are for the purpose of holding pipe roll castings. At the rear of the machine, mounted on the rear of the bed is a roll forming attachment, the purpose of which is to impart curved surfaces to long pipe straightening rolls. It operates on the principle of a taper attachment. A shoe, provided with anti-friction rollers, slides in a trough following master bars, thus generating the same curve on the rolls being turned. Straight work can be turned by simply disengaging the nut which holds the shoe, and by tightening the cross-feed nut. A concaving rest for semi-circular grooves is interchangeable with the compound rest, and is used for grooving out pipe welding rolls, with a capacity for rolls for pipe from 2 to 20 inches diameter, a limiting gage being provided for setting the tool to any desired diameter. This rest operates with rotary motion, through a worm and worm wheel, with either hand or power feed, the latter being derived through the feed rod and carriage with all the advantages of the regular feeds.

THIRTY-INCH BORING AND TURNING MILL.

The boring and turning mill illustrated herewith has just been placed on the market by the Baush Machine Tool Co., Springfield, Mass. It is built with a swivel turret head and swings 32 inches in diameter and 15 inches under the cross rail. The chuck or faceplate has eight changes of speed. It is bolted to a large driving gear which has an outer bearing with automatic oiling device arranged in the bed so as to keep the bearings well lubricated. The center spindle is 7 inches in diameter and 18 inches in length, and is made with angular bearing to receive side strains, with check nuts on the under side of the spindle to prevent any lifting tendency. The turret has five sides—10 inches across the flats—and five 2 3-16-inch

holes. The turret slide has a traverse of 16 inches and in the swivel head can be set over at any angle up to 30 degrees, and will face 30 inches diameter. The vertical feeds have 20 changes, and the horizontal feeds also 20 changes. A cone of large diameter, having a 3-inch belt, drives this mill, but it can be equipped with motor drive at any time. Back gears can be changed by means of a lever without the use of a lock-nut.

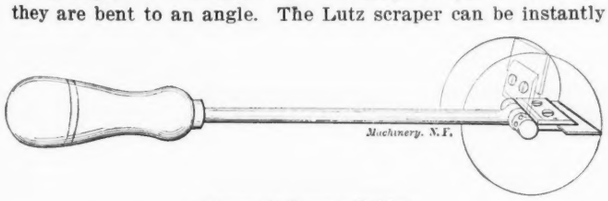


Baush Boring and Turning Mill.

The machine is self-contained and does not require an expensive foundation. On the upright of this mill is a Hendey-Norton change gear device for feeding and thread cutting. Threads from 5 to 20 to the inch can be cut. The mill weighs 5,900 pounds.

LUTZ ADJUSTABLE SCRAPER HOLDER.

The cut shows a convenient scraper holder made by the Lutz Tool Company, Springfield, Ohio. It is adjustable, which feature makes it convenient for finishing flat, grooved, curved or angular surfaces, and for getting down to the faces of small valve seats, for instance, which, in some designs of engines and pumps, are inaccessible to ordinary scrapers save when they are bent to an angle. The Lutz scraper can be instantly



Adjustable Scraper Holder.

adjusted and securely locked at any required angle. It holds any size blade up to 2½ inches, and the blades can be quickly changed for others when special shapes are required, etc. The holder is a steel drop forging, well finished, making a handsome and durable tool that should be highly prized by mechanics who have much close and accurate fitting to do.

SHAPER FOR HEAVY WORK.

The cuts herewith show the "Queen City" 16-inch crank shaper especially designed for heavy duty and durability. The column is large and very heavy, and is reinforced where necessary to resist working strain. The design of the ram is original. The arch construction brings the maximum section of metal into service at the point where leverage is greatest, that is, when the cutting tool is at its extreme forward position. The bearing for the ram is 30¼ x 10 inches, and the slides for same overhang, thus giving the tool increased stiffness. The position of ram and the length of stroke can be changed without leaving the work and while the tool is in motion or at rest.

The rail, too, is very heavy; the cross traverse is 21 inches and the screw has a graduated collar. A vertical adjustment can be obtained by the use of bevel gears provided with ball bearings.

The rocker arm is connected to the ram by means of a link which gives a straight pull, an even cutting speed, with quick return and no lost motion. Fig. 2, on the next page, shows this construction, and also the excellent adjustment to compensate for wear of the crank shoe. The table has a V for holding shafts and similar work vertically, and can be readily detached from the saddle. An extension provides for a broad clamping surface, and the manufacturers, the Queen City Mche. Tool Co., Cincinnati, O., will furnish an outer support if desired.

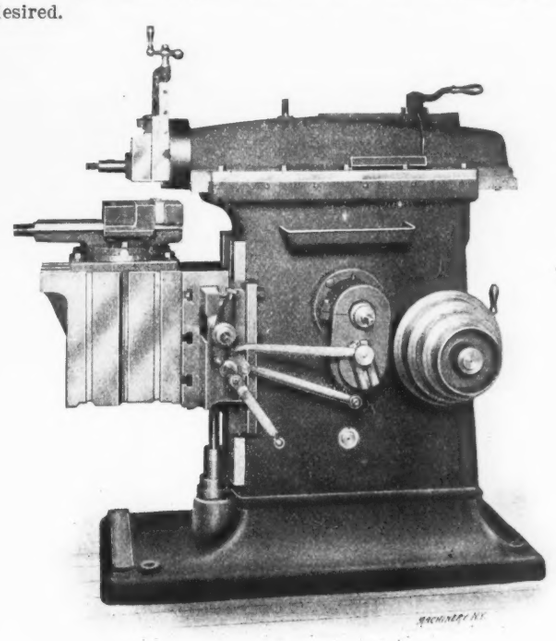


Fig. 1. Shaper for Heavy Work.

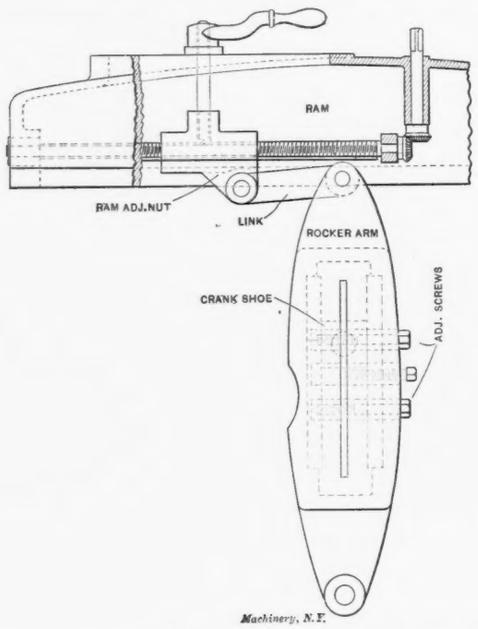
The vise is of the planer type and is stiff enough to hold the work solid even on angle cuts. The flat wearing surfaces are scraped to a standard surface plate and are very wide. All extra attachments, such as power down feed, concave attachments, tilting and removing table, etc., are furnished when required.

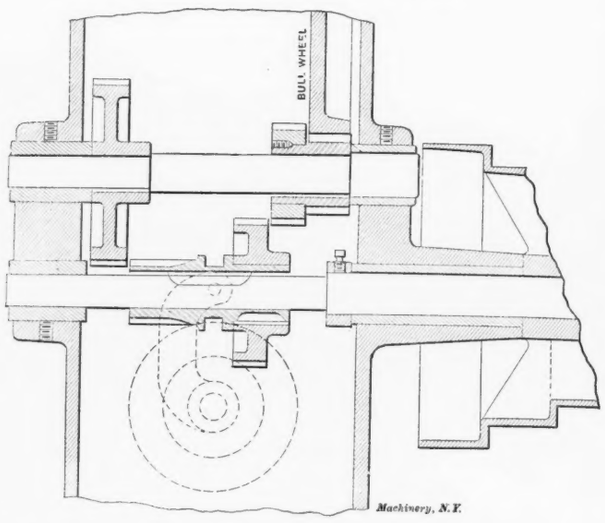
THE GORHAM HEATING FURNACE.

The cut herewith is of the "Gorham" revolving forge furnace now being built and sold by the National Machinery Co., Tiffin, O. This is an oil or gas-burning furnace, and is especially suitable for use in connection with bolt headers, or forging machines, for heating bolt blanks, wheel spokes and similar forgings.

The design of this furnace is such that its four sides are used as heating surfaces. The furnace proper turns on a ball bearing base, and is revolved by the attendant with extreme ease. This arrangement requires but little floor space, and as only one side of the furnace faces the operator the heat radiated upon him is slight. There is a large economy of fuel in comparison with a horizontal furnace of equal capacity, as the irons to be heated are in the most advantageous place, i. e., where the hot gases concentrate, and where the heat is most intense. Furthermore, the heating effect is uniform, as

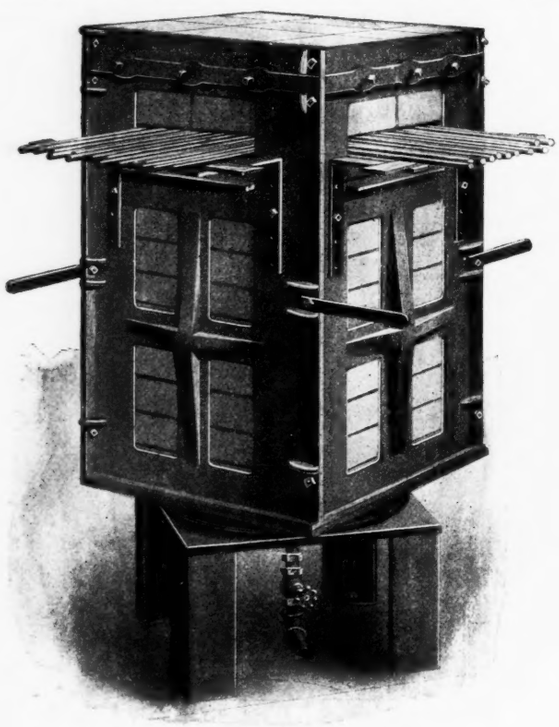
the irons are practically equidistant from the burner, and will heat at the same rate of speed. The lining and also the top of the furnace are made of commercial size 9-inch fire brick, and no especially molded tile is required. Either low or high-pressure burners are used; one requiring an air blast of about





Figs. 2 and 3. Details of Ram, Rocker Arm and Back Gears of the Queen City Sixteen-inch Crank Shaper.

eight ounces per square inch, and the other a blast of fifteen pounds or more per square inch. The latter is recommended as being the most convenient and economical. The burner is attached to the base of the furnace, and is vertical and stationary, and requires no swivel joints. The spray of air and oil passes from the burner through a flue at the bottom of the chamber, strikes against a baffle brick and ignites after passing it. As stated above, the heating chamber is vertical and revolving, and although a few vent holes are provided upon the top, a chimney is unnecessary, as the combustion is practically perfect, and the escape of gas is slight. The openings in the top of the sides of the heating chamber are to be partially bricked in, leaving suitable slots to receive the irons to be heated. Suitable lighting and slag holes are provided, and the internal arrangements prevent slag from flowing into and clogging the burner flue.



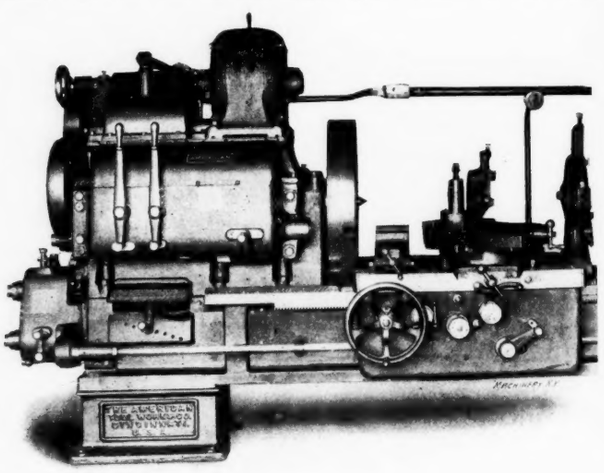
The Gornam Revolving Furnace.

The approximate output per hour is four hundred 1-inch, seven hundred ¾-inch or one thousand ½-inch blanks heated three diameters in length. The net weight of this machine complete with lining is 1,400 pounds. The floor space occupied is 21 x 21 inches, and the height is 4 feet.

THIRTY-INCH AMERICAN ENGINE LATHE.

The cut herewith shows a 30-inch engine lathe equipped with an interesting method of motor drive, and built by the American Tool Works Co., Cincinnati, O. The drive is designed for a constant-speed motor, either direct or alternating current. The various spindle speeds are obtained mechanically through the gear-driven headstock, the mechanism of which consists of a patent clutch and gear arrangement employing the minimum number of gears and shafts for such a device.

Through manipulation of the levers at the front of the head, and the one at the lower right corner of the head,



Thirty-inch Engine Lathe, American Tool Works Company.

sixteen distinct and positive speeds to the spindle are provided, in geometrical progression, ranging from 3.8 to 246. Thus a wide range is obtained entirely through mechanical means, sufficient to cover the ordinary work of this lathe. As the construction is simple, all gears and shafts can be made of large diameters. The whole is neatly incased, and all parts are accessible for lubrication.

A non-reversible constant speed motor may be used if desired, because the reverse is obtained mechanically, by means of the rod shown mounted above the lathe, out of the way,

yet convenient to the operator. The good feature of this construction is that the motor is at no time reversed, but runs at continuous constant speed, all starting, stopping and reversing of the machine being accomplished without interference with the motor.

The motor is substantially mounted above the all-gear headstock, and the lathe may be at any time converted into a belt-driven machine by replacing the motor by a single pulley mounted on the upper shaft.

SPECIAL HIGH-SPEED LATHE.

The lathe shown in the cut, Fig. 1, has recently been designed by P. Blaisdell & Co., Worcester, Mass., to meet the demand for a powerful tool, with a wide range of geared speeds, created by the increasing use of high speed steels. With two ratios of back gearing, 3½ and 12 to 1, and the three-speed countershaft, 27 spindle speeds are obtainable, 18 of which are geared. There are 90 positive feeds ranging from 8 to 288. The feed mechanism is shown, in detail, in Fig. 2. The change of feed is effected by the lateral movement of a rod which slides in the hollow shaft that carries the lower cone of gears. This rod, which is actuated by the lever at the right-hand side of the feed box, is fitted with a spring feather-key, which is hinged at one end of the slot milled to receive it. The projection on the free end of this key has a bevel on either side of it, so that when being shifted from one gear to another, it is depressed flush with the shaft and snaps into the keyway in the gear as soon as that matches with it. This is a novel form of feather-key and gives a simple and strong construction, free from the jolt and wear that is so objectionable in the usual form of sliding feather-key. The feeds are reversed from the carriage by means of the lever at the right of the apron in Fig. 1. This motion imparted by this lever to the lower one of the two shafts on the front of the lathe, is transmitted, through the arm on the opposite end of this shaft, to the reversing gear, which is contained within the headstock. The carriage is fitted with a graduated, compound rest, and the power cross and angular feeds have graduated adjustment.

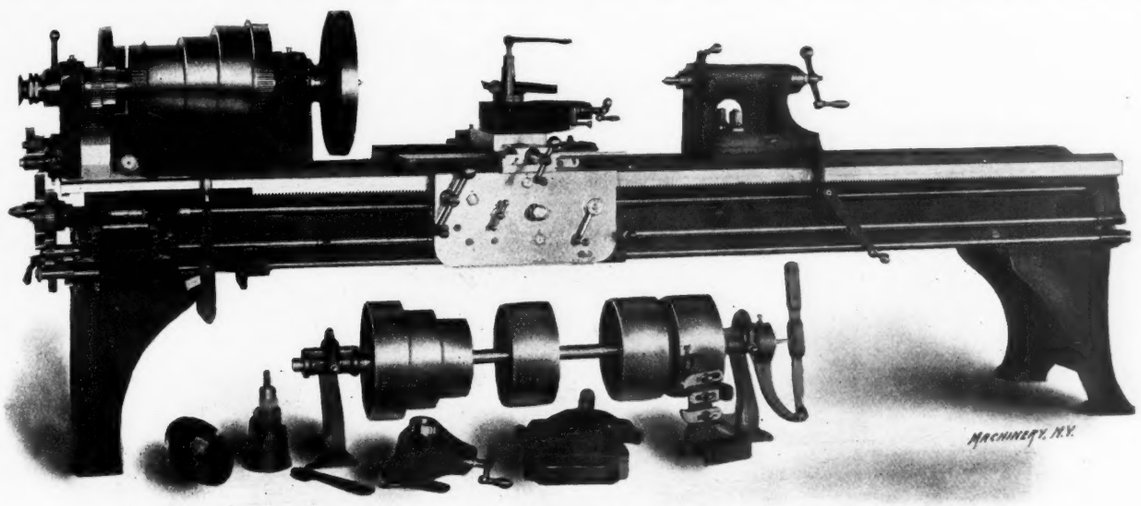


Fig. 1. High-speed Blaisdell Lathe.

The lathe shown in the half-tone swings 22 inches clear of the shears. The front spindle bearing is 3½ inches in diameter by 5½ inches long, and the hole through the spindle

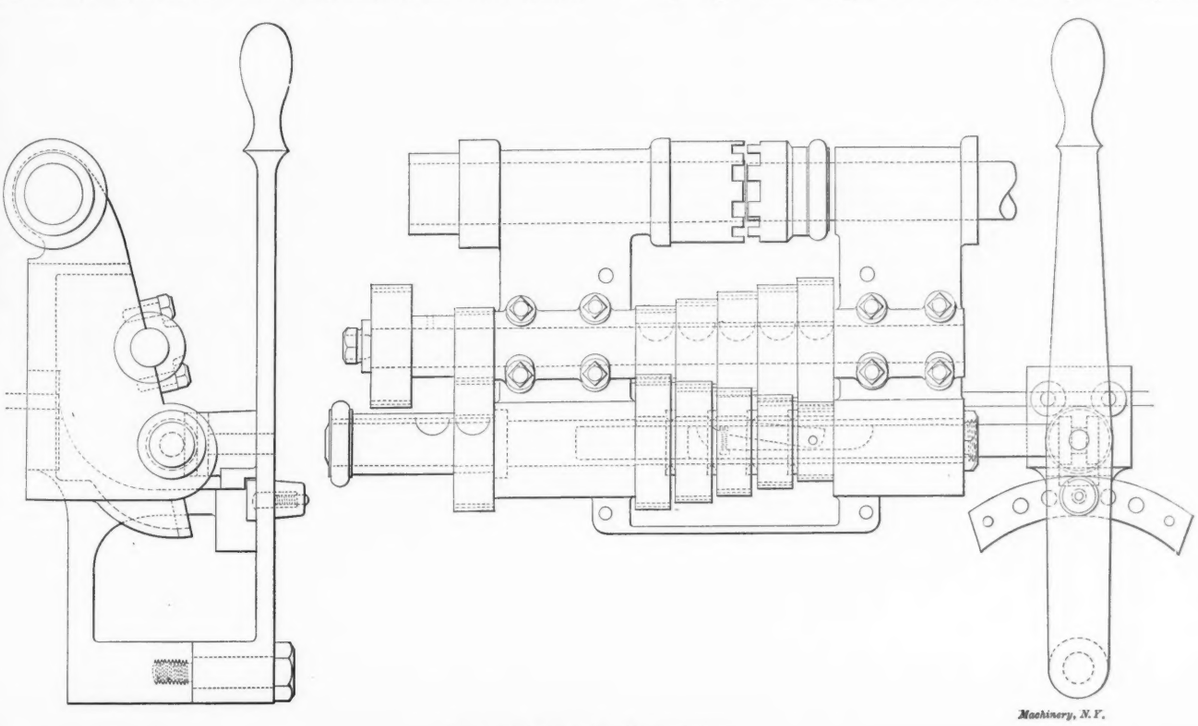
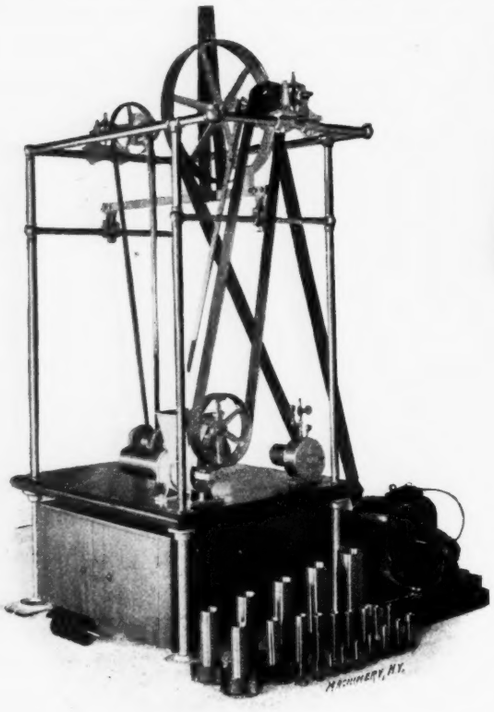


Fig. 2. Details of Feed Mechanism.

1 7-16 inches in diameter. The cone steps are: 9¼ inches; 11⅝ inches and 14 inches by 3⅞ inches face. The tail-stock spindle has a diameter of 2⅜ inches. A pulley-turning attachment is furnished, if desired, and it is claimed for this machine that it will turn out 100 pulleys, 12 x 5 inches, in 10 hours. In manufacturing shops, particularly, where heavy cuts and cross feeds are the rule, the lathe will be favorably received.

CORE-MAKING MACHINE.

A machine for making cores, the invention of Mr. G. H. Wadsworth, and now being built for the market by the Falls Rivet and Machine Co., Cuyahoga Falls, O., is shown in the accompanying illustration. The vital principal of this machine is new only as applied to the making of cores, being simply the screw, or helical conveyor, such as is used in the sausage mill and in some brick machines. Mr. Wadsworth's machine, however, has many features to recommend it to foundrymen. It will make properly vented cores, of uniform density in round, square, hexagon, oblong, T-shaped, or in fact, in any shape for which the proper dies are made. The cores produced by this machine are very smooth and do not require blackening or slicking, and as they can be made in long lengths, there is a saving in oven room. The range of work produced by the machine embraces 24 sizes of perfectly round cores, ranging from ⅜ inches to 6 inches in diameter, and almost any length desired; 6 inch cores having been made 10 feet 6 inches long. The venting is done by a stationary rod, which passes through a hole in the center of the shaft which carries the screw. Contrary to expectation the wear on this venting rod and on the disks is so slight as to be hardly noticeable. The cores are coned at the ends by being held against an emery wheel at the proper angle, in a device similar to that used in the twist drill grinder.



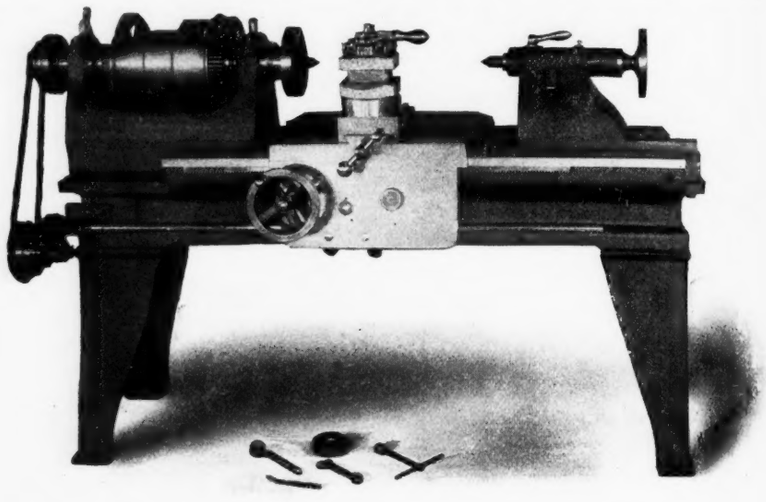
Wadsworth Core-making Machine.

We are informed that upon a basis of an expenditure of 10 cents for wages and a production of from 200 to 600 feet of core per hour, the Wadsworth machine will make from 20 to 60 feet of finished core for one cent.

ACCURATE TAPER TURNING LATHE.

A lathe for turning positive tapers on work of different lengths, without resetting, has recently been put on the market by Fay & Scott, Dexter, Me. The head and tail-stocks of this lathe are fitted to a swivel plate, which is contained within and is independent of the sheaves upon which the tool carriage travels. As the lathe centers always remain in line, and the tool carriage travels perfectly free, without the interference of the usual taper attachment, the work turned out by this machine is very accurate. A point which will, no doubt, make the tool popular with the men in the shop is the absence of back lash in the slide rest, and the consequent trouble in adjusting the tool to turn the size desired, as is the case when lathes are fitted with the usual taper attachment. The carriage is fitted with an automatic stop motion for throwing out the feed, allowing the carriage to be run back without loosening any friction device. This lathe is well adapted to toolroom use, where accuracy in turning taper reamers and taps is essential.

The accompanying illustration is from a photograph of an 18-inch lathe of this pattern. The swivel plate projects beyond the shears at the tail of the lathe. The principal specifications are: Ratio of back gearing, 11 to 1; swing over bed, 18½ inches; swing over carriage, 12 inches; cone diameter, 5 to 10 inches; width of steps on cone 3⅞ inches; hole through spindle, 1⅝ inches; front bearing of spindle, 2 11-16 inches diameter by 5 1-16 inches long; diameter of tail stock spindle, 1⅞ inches, and with a 6-foot bed it will take 30 inches between the centers. The spindles are chucked for Morse taper No. 4.

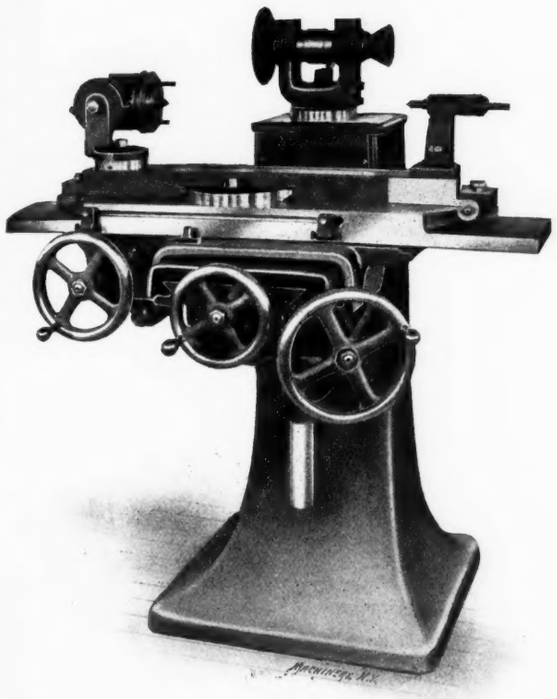


Fay & Scott Taper-turning Lathe.

UNIVERSAL CUTTER GRINDER.

The half-tone herewith shows a newly-designed universal cutter and tool grinder which will grind all work within its range to a great degree of accuracy. Taking the fact into consideration that a grinder must be absolutely rigid and free from vibration if it is to do accurate work, special attention was given in designing this machine to attain this end. The column, as well as knee, saddle, slide and table, are of box form with internal braces. The wheel spindle frame can be swiveled 180 degrees; the base is graduated and locked in any position, it is dust-proof and can be adjusted to compensate for wear. All the bearings, slides and screws are covered. The adjusting hand wheels are of large size and are graduated on the outside, reading to a thousandth. The table is swiveled on a central stud and clamped in any position, has graduated arc in front, reading to degrees, and there is a scale on the slide which reads to 3-inch taper per foot either way. One end of the table is formed to a wormwheel, into which engages a worm by means of which the table can be readily adjusted either way to the desired taper.

For all operations there is but one tooth rest used; it has a micrometer adjustment and can be set in any position. The dimensions of the machine are: Table movement, longitudinal, 15 inches; cross movement, 8 inches; vertical movement, 7 inches; swings between centers, 9 inches, with raising blocks 12 inches by 20 inches long; grinds 16-inch face mills, 36-inch saws. Many operations can be done on this grinder for which other grinders require special attachments such as grinding gear cutters, face of teeth in taps, formed cutters, hobs, etc.



Oesterlein Cutter Grinder.

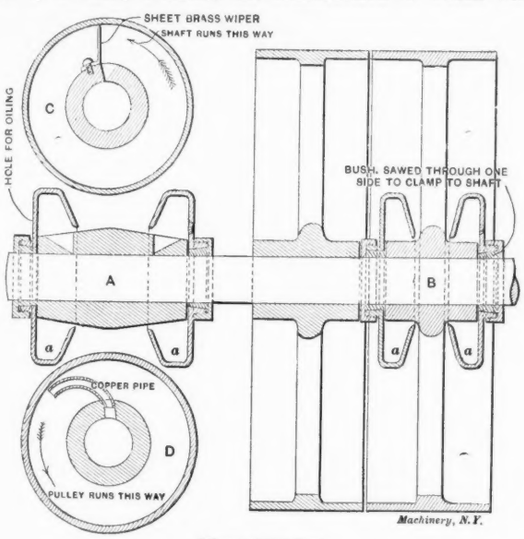
With this machine is furnished a 3-inch chuck, swivel vise, main and drum countershaft and a set of grinding wheels.

It is being built by the Oesterlein Machine Co., Cincinnati, O.

THE ALLMOND OIL CUP.

A type of oil cup is illustrated herewith which has been applied successfully to the loose pulleys of countershafts and the main bearings of countershafts, line shafts, etc. It is manufactured by Charles H. Allmond, 804 First avenue, So., Seattle, Wash.

At *A* in the illustration is shown the oil cup as applied to a stationary bearing, and at *B* as applied to a loose pulley. In both cases the cups which retain the oil are secured to the shaft by a clamp bushing, the construction of which will be

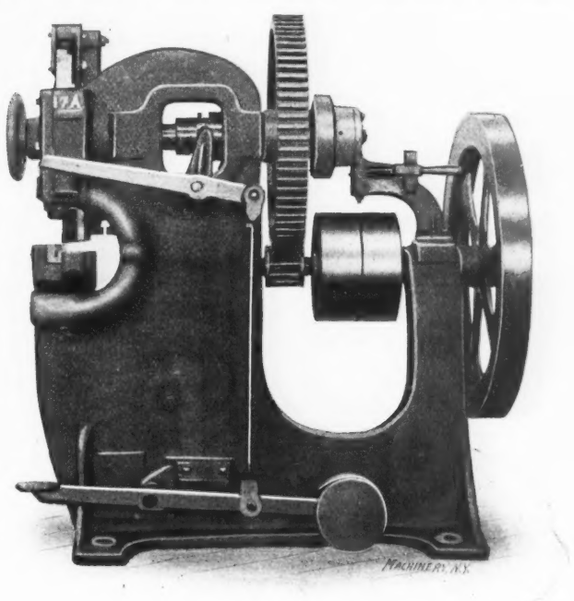


Allmond Oil Cup.

evident from the sketch. The part of the bushing that fits the shaft is split, and, by screwing the two threaded portions together, the outer part of the cup is drawn over the inner taper bushing which securely clamps the latter to the shaft. When the shaft is stationary the oil simply remains in the lower part of the cup at *a a*. When the shaft rotates, the oil is thrown out by centrifugal force to the outer periphery of the cup where it would remain except that it is impeded in its motion by a suitable wiper which carries it back to the bearing. The kind of wiper that is used depends upon whether the cup is applied to a stationary bearing or to a loose pulley. In the former case the construction shown at *C* is used. Here the oil, as it revolves with the cup, is caught by the piece of sheet brass and caused to flow inward to the bearing. At *B* and *D* are shown the construction for the loose pulley. When the loose pulley is running the cup is stationary and the oil remains at the bottom. A bent copper pipe inserted in the hub of the loose pulley, however, scoops part of the oil at each rotation of the pulley and carries it to the shaft. Mr. Allmond writes that the countershaft illustrated in the sketch is one applied to woodworking machinery, and that it has run 16 days with one oiling and that there is no drip or spatter of the oil. He has also applied the cups to the top wheel and loose pulleys of band saws. Another instance is on a line shaft running 550 revolutions. With cast iron boxes it was found that the shaft runs without heating. Mr. Allmond has a shop fitted throughout with the oil cups, which, he writes, require attention but once a week and give entire satisfaction.

NEW T-IRON NOTCHING TOOL.

The accompanying cut illustrates a tool which will prove of interest to any one requiring T or angle iron with leg notched or cut away flush with the remaining leg. The knives are so arranged that the leg can be cut away either at the end or at any point in length of the bar, and length of cut can be varied

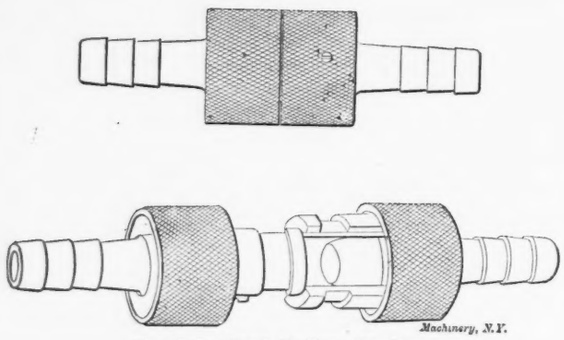


to suit requirements. The side knives are so arranged that either a straight or angular cut can be made on the leg being notched.

For work of this kind the makers claim it to be a very efficient and labor-saving tool. This machine was recently built by the New Doty Mfg. Co., Janesville, Wis.

AIR HOSE COUPLING.

A simple, strong and quick-acting hose coupling, for use in connection with pneumatic tools, known as the "Giv't-a-twist" air hose coupling has recently been placed on the market by the Ingersoll-Sergeant Drill Co., 26 Cortlandt Street, New York. As will be seen from the sketch, no wrench or spanner is required to either couple or uncouple the parts. To make a coupling it is only necessary to push the halves together by hand and slightly twist the locking rings in opposite directions. To uncouple, the operation is reversed. Both halves of the coupling being identically the same, the usual necessity of mating the ends is obviated. There are no projections to catch or break off by the hose being dragged from place to place. The rubber sleeve is entirely encased when the coupling is made, and will withstand any working pressure without leakage. The parts are made of brass, extra heavy, to stand rough usage, and are machined throughout,

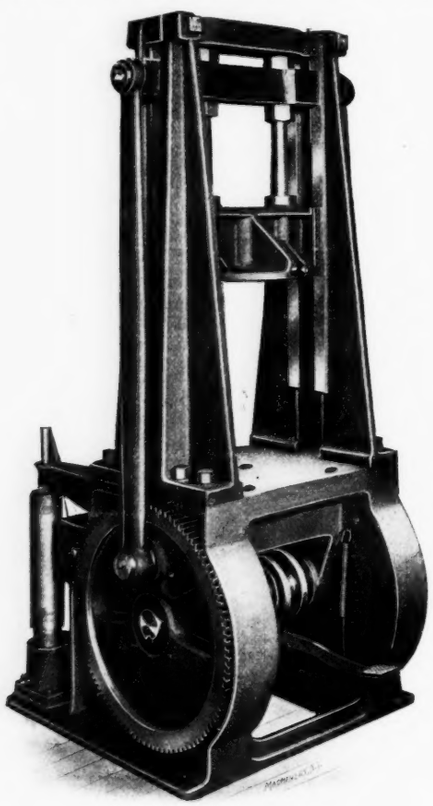


The Giv't-a-Twist Air Hose Coupling

This coupling is manufactured in all standard sizes for connection: Hose to hose, hose to pipe, or pipe to pipe with male and female shanks.

NEW WIRING PRESS.

The illustration herewith is of a wiring press recently completed by the E. W. Bliss Co., Brooklyn, N. Y. It was designed to obviate the slow and laborious handling of large and heavy dies. The stroke of slide is sufficiently long to raise the punch high enough to permit of insertion in the die of the article to be wired, or its removal, without disturbing the die. A good



Wiring Press, E. W. Bliss Company.

operator can catch every stroke of the press. The slide plate generally used on a wiring press for moving the die back and forth to insert or remove the article to be wired is not used on this press; the long stroke makes it unnecessary to handle the die. This saves much time and labor and increases considerably the output of the machine.

The press is provided with a powerful friction clutch and the slide is counterweighted. The principal dimensions are: Weight, 3,600 pounds; it will wire up to (diameter and depth) 15 x 12 inches; distance from bed to slide, stroke down and adjustment up, 16 inches; distance between gibs, 20 inches.

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FRESH FROM THE PRESS.

ANNUAL OFFICIAL DIRECTORY OF THE TEXTILE INDUSTRIES AND THE YARN TRADE. 1904 Edition. Published by the Lord & Nagle Co., 299 Devonshire St., Boston, Mass. Bound in cloth. Standard size, 6x9. 528 pages. Price Travelers' edition, $2.00; office edition, larger size, $2.50.

This work is divided into five parts, as follows: Part I., Textile Manufacturers; Part II., the Yarn Trade Index; Part III., Classified Lists of Commission and Order Mills, Dyeing Establishments; Part IV., Dealers in Raw Materials and Stock; Part V., Agents and Buyers of Textile Fabrics. Very full information is given on the subjects included under these various headings, and about 20 textile maps, showing the location of cities and towns where there are textile industries, are to be found. The work has been thoroughly revised and brought up to date.

DIRECTORY TO THE IRON AND STEEL WORKS OF THE UNITED STATES. Sixteenth edition, 1904. Published by the Iron and Steel Association, 261 South Fourth street, Philadelphia, Pa. Bound in cloth. 468 pages. Corrected to August 1, 1904. Price, $10.00.

This book, which is compiled and published by the above named company, embraces a full description of the blast furnaces, rolling mills, steel works, tin plate and terne plate works, and forges and bloomaries in the United States. Also classified lists of the wire rod mills, the structural mills, plate sheet and skelp mills, black plate mills, rail mills, steel casting works, Bessemer steel works, open-hearth steel works and crucible steel works. This has been thoroughly revised and brought up to date and the publishers call attention in the preface to the fact that inquiries submitted to manufacturers were even more searching and more comprehensive than for previous editions, so that the information on the above-mentioned subjects is complete and reliable. A very full table of contents and complete index are also to be found in this edition.

FORGE PRACTICE. By John L. Bacon, Instructor of Forge Work, Lewis Institute, Chicago, Ill. 257 pages, 4¾x7¼ inches, and 272 cuts. Published by John Wiley & Sons, New York. Price $1.50.

Although this work is dubbed an elementary one by the author, being the outgrowth of a series of notes given to the students of Lewis Institute on forge work, it is eminently practical and contains much that should be helpful to the working smith. The text is free from padding and is right to the point, being expressed in language remarkably clear and easy to comprehend. Following a general description of the forge and tools is a chapter on welding, and then in order are chapters on calculation of stock for bent shapes; upsetting, drawing out and bending; simple forged work; calculation of stock, and making general forgings; steam hammer work; duplicate work, metallurgy of iron and steel; tool steel work; tool forging and tempering, etc. The sketches are well drawn, many of them being in perspective which is best for illustrating work of this character. The book is one that should be popular in trade schools and similar institutions giving instructions in practical forge work.

BEVEL GEAR TABLES, by D. Ag. Engstrom. 66 pages, 5½x7¼ inches with eight cuts. Published by the Derry-Collard Co., 256 Broadway, New York. Price, $1.00.

This little book is not a treatise on bevel gears, but is intended to help the practical man who has little knowledge of trigonometry, or who is too busy to resort to the calculations involved. In the preliminary explanation of the terms and use of the tables a very clear conception of the elements of bevel gears is conveyed to the reader. The tables are successively calculated for gears of 12 to 47 teeth, inclusive, mating with gears of 12 to 47 teeth, inclusive, thus making thirty-six tables in all. These tables give without calculation the outside diameter, placing distance, outside cone radius, face angle, edge angle, cutting angle and number of cutter, all for a diametral pitch of 1. Other diametral pitches are simply obtained by dividing the given distances by the required pitch, the angles, of course, remaining the same. For circular pitch, the values in the tables are multiplied by the "diameter" pitch which is the reciprocal of diametral pitch, and a table of diameter pitches is given for circular pitches from 1 1-16 to 3 inches, inclusive.

AIR BRAKE TESTS, compiled by the Westinghouse Air Brake Company. 323 pages, 4½ x 7 inches, and 130 cuts. Bound in limp leather. Published by the Company at Wilmerding, Pa.

This book is a compilation of the principal tests of air brakes that have been made in this country and abroad to determine the factors that affect braking efficiency. The opening chapter is a brief resume of the history of braking, leading up to the introduction of the "Straight-air" brake by Mr. George Westinghouse in 1869, which was the forerunner of the automatic air brake now in general use on railway trains throughout the world. Then follow the three papers read by Capt. Douglas Galton before the Institution of Mechanical Engineers, describing the now historic Galton-Westinghouse air brake trials made in England in 1878-79, on the London, Brighton and South Coast Railway, and the North Eastern Railway. The Paris and Orleans Railway tests were made in 1879, and following the description of these is that of the Burlington brake trials in 1886-87, which are treated at length, 116 pages being given over to these famous tests. Then follow the Westinghouse freight train tests, made in 1887; the Karner tests on the New York Central, in 1892; the Sang Hollow tests on the Pennsylvania Railroad, in 1900; the Shiproad tests on the same railway in 1894; the Nashville locomotive tests; the Absecon tests; and the Atsion tests. The book is one that will interest the advanced air brake man and the mechanical engineer.

MACHINE DESIGN, by Charles Lewis Griffin, S.B. Published by the author, Syracuse, N. Y. 183 8-vo pages. Illustrated. Price $1.50.

Mr. Griffin is experienced as an instructor in machine design, but has recently again taken up engineering work along commercial lines. The matter in this book is the result of his experience both in designing machinery and in teaching. It comprises matter that he has proposed to publish for the benefit of his students, but which he has not had an opportunity to publish until recently. It is practically the same as was prepared by him for the use of the American School of Correspondence, Chicago, and which we have already referred to in these columns.

The book is along strictly original lines and its distinguishing characteristic is that it teaches the method of designing rather than giving a great quantity of data and leaving the student in the dark as to the method of applying the data. It takes up, in the first place, the design of a simple but complete machine and shows how the draftsman would go to work to gather his data, make preliminary calculations, lay out the work on the sheet, and finally detail the work to the draftsman under him for making the finished drawings. This whole process is worked out clearly by means of freehand and finished sketches, calculations as they would be made by the draftsman in his notebook, etc. In the second part of the volume the elements of machine design are treated, such as belts, pulleys, shafts, gears, friction clutches, bolts, keys, etc. If a student wishes to really learn how to design machinery, by home study, or if an instructor wishes to lead his students along correct paths in machine design, we think that either will find this treatise unusually well adapted for the purpose.

AMERICAN SMALL ARMS, by Edward S. Farrow, late Instructor of Tactics at the United States Military Academy, West Point, etc. 408 pages, 7x10¼ inches, and 500 cuts. Bound in green cloth with gilt top. Published by the Bradford Company, New York. Price, $5.00.

Mr. Farrow was led to the compilation of this interesting work by noting the great variety of American small arms found in the possession of a tribe of Indians which he captured some twenty-five years ago while in the U. S. Army service; and the fact that there is, or was, an almost complete absence of writings on the subject. This